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ABSTRACT

Each issue in this set of newsletters is devoted exclusively to reviews of a science textbook. Each text is reviewed by two scientists and one science educator. Textbooks reviewed by issue are: (1) "Scott, Foresman Biology" (1988); (2) "Heath Life Science" (1987); (3) "Prentice-Hall Biology" (1987); (4) "Scott, Foresman Life Science" (1987); (5) "Heath Earth Science" (1987); (6) "Prentice-Hall Life Science" (1988); (7) "Holt Modern Biology" (1989) and (8) "Merrill Biology" (1988). (YP)

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BOOKWATCH

A CANDID REVIEW OF SCIENCE TEXTBOOKS

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IN THIS ISSUE:

three reviews of *Scott, Foresman Biology* 1988 teacher's edition ISBN = 0-673-22341-8
Scott, Foresman and Company, 1900 East Lake Avenue, Glenview, Illinois 60025

Biology? What Biology? For any practical purpose, *Scott, Foresman Biology* 1988 is the same as the 1985 version, but with "1988" added to the copyright page. Our question is: Does this book *have* any practical purpose? As our reviewers explain, it cannot be used as a biology text.

Scott, Foresman's product offers facts, pseudofacts and clichés in a matrix of rote sentences and plentiful pictures. It continually fails to integrate information, to explain concepts or to explain biology, and it is rich in absurdity. The writers reduce the topic of "scientific methods" to two paragraphs within a confusing passage on "The Origin of Life." They crunch the topic of marine biomes into two sentences and a picture of a coral reef. They guess that notochords consist of cartilage; that a human has "donut-shaped" red cells; that a fish has hipbones and a human-type pelvis; that the singular of *meninges* is "meninge." They minimize environmental problems in paragraphs recalling Pangloss and Pollyanna. They depict the hazardous dumping of chemical wastes as something "in the past." Their appendix "Nobel Laureates in Physiology or Medicine" lists the laureates and tells the nationality of each, but it gives no hint of what they did to win their prizes. Like the book as a whole, it is attractive but scientifically meaningless.

More than a third of the book is a survey of organisms, from viruses through vertebrates. The whole exercise is contrived and misleading, for it lacks a basis in science. It projects the impression that scientists classify organisms merely by noting features—much as one might sort shoes—rather than by trying to isolate those features that bespeak evolutionary relationships. If students relied on Scott, Foresman's parody, they might learn about some groups, but they would not know what the groups represent. Nor would they be able to say why groups exist in nature at all. To explain those things, the writers would have had to explain phylogeny and the role of phylogenetic thinking in taxonomy. They have avoided that, however, and have produced 260 pages about shoe-sorting. This might have passed for science a long time ago; today it looks only like backwardness and an attempt to foster a view of nature based on fundamentalist religion. Similar backwardness affects other parts of the book, as the reviews by De Santo and Nickels tell.

William V. Mayer, Editor-in-Chief
William J. Bennetta, Editor

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Rote Is Not Right

by Robert S. De Santo

Scott, Foresman's book cannot serve as a primary textbook in biology. Biology is a science, but this book does not present science. It presents a frenetic display of facts—a smothering blanket of facts—and it will not inspire scientific thinking in any student or teacher. At most, it will impart an artificial and shallow sense of learning while it damages imagination and creativity.

Before I tell more about the book, I must tell about my own perspective. For the past 25 years years or so, I have earned my living as an ecologist. I work now for a company of consultants in engineering and transportation-planning, and my job revolves around the application of biological information and biological thinking to the solution of environmental problems. The practical use of scientific thought is therefore important to me. So is the managing of employees who can understand, practice and communicate scientific methods, and who can tackle ecological problems with curiosity, imagination and perseverance. Finding such employees is not easy, and it will only become harder for as long as we perpetuate the kind of "science education" represented by Scott, Foresman's book.

The blame for the book does not belong entirely to Scott, Foresman. In principle, the responsibility for solving the fundamental problems of preparing a biology text should rest with people who understand science, who want earnestly to communicate the principles and rigor and delights of science, and who can skillfully write curricula. It should not rest with merchants or with writers who know little of either science or education. In practice, however, our educational establishment has failed in its responsibility. Our curricula—as they are reflected in typical textbooks—seem to ignore all the things that are important, or to dismiss them with demeaning, misleading lip service.

What things are important? First, the principles and methods of science, and a real understanding of how these make science different from other endeavors. Next, the history of science: the discoveries, the people who made them, and an understanding of how every great discovery involved the integration of earlier findings and the extension of earlier thought. And most importantly, an appreciation of science as a creative intellectual process.

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Many of our students are getting none of that. Instead, they get recipes—recipes dispensed by a system that, one might suspect, was designed to misguide and discourage young people. It turns their experiences with science into tedious exercises, loading their memories with litanies of facts while making inhuman demands on their attentiveness. Students who are content to memorize are rewarded by this system. Those who try to integrate information, or to make new associations among facts, usually are mocked—if only because the facts that they have learned are so sketchy and incoherent that the making of associations is a bitterly hard task. The system likes rote learning, rote teaching, rote teachers and rote textbooks.

This is the system for which *Scott, Foresman Biology* 1988 has been produced. The book tries to provide a complete, rote recipe for a course in biology, and the advertising on page T6 of the teacher's edition proclaims: "Content that's complete, up-to-date, relevant to students, and organized around the most current five-kingdom classification system. It's all here."

Well, it's not all there. What *is* there is fact-babbling that I can illustrate by citing seven pages (637 through 643) in a chapter about ecology. In those seven pages, the writers introduce, define and dispose of the terms *biotic, abiotic, biotic potential, carrying capacity, density-dependent, density-independent, dominant species, habitat, niche, competition, predation, mutualism, parasitism, symbiosis* and *commensalism*. Yet each such term—and the concept that the term signifies—demands careful explanation, diverse exemplification, and considerable effort by both student and teacher if it is to be integrated into the student's working intellect. All those concepts are vital to an understanding of the living world, and some of them have aspects that are truly subtle. I am sorry for the thoughtful student who might try to learn about them from Scott, Foresman's book.

The scope of the book is conventional and comprises ten units: Life; Cells; Genetics; Evolutionary Theory; Viruses, Monerans, Protists, and Fungi; The Plants; The Invertebrates; The Vertebrates; Human Structure and Function; and Ecology. That is a conventionally encyclopedic array, and the book is in fact a kind of encyclopedia. It presents many discrete articles and vignettes, some of which may be useful sources of facts in specific situations, but it has no unifying theme. It certainly does not elucidate the great themes of biology. It does not, for example, provide insight into the overarching unity of life, nor does it reconcile the unity of life with the spectacular diversity of life.

One reason why it does not do those things is obvious. This is one of those "biology" books that avoid the principle of biological evolution—the principle that enables us logically to handle the relations among different forms of life, to comprehend the malleability of life, and to explain diversity in a context of unity. With only one evident exception, significant references to evolution are quarantined in the two-chapter unit called "Evolutionary Theory," as if evolution had nothing to do with subjects covered in other units—plants or invertebrates or vertebrates or human structure or ecology. Here and there we find odd allusions to evolution, some of them wrong or misleading; but the writers are oblivious to the central role of evolutionary thought in today's biology. No wonder that their book is so bad.

The ecology unit, as I have told, is the last. It is a failure. It fails first because it does not integrate ecology with subjects that have been treated in earlier units and that are inextricably related to ecology: subjects such as cell biology, physiology, anatomy and genetics. It fails again by getting things wrong. (For example: It dismisses tropical rain forests in three fluffy paragraphs suggesting that there is a single, uniform biome called *the* tropical rain forest, and that leopards dwell in Mexico as well as Africa, and that anacondas "roam the forest floor" in Asia as well as Amazonia.) It fails again because it tritely describes a few problems posed by our technological abuse of our planet, but it ignores some of the worst ones. It fails again because it does not elucidate our only real hope for solving our ecological problems. That hope lies in environmental stewardship —in recognizing that we are a part of nature rather than apart from nature, and in managing Earth accordingly.

While *Scott, Foresman Biology* 1988 cannot be used as a textbook, it may merit consideration as a reference book. If it were cast in that role, students could enjoy its better features: good layout and illustrations, good integration of illustrations with text, and (of course) a mighty abundance of facts. Use it in the library, not in the classroom. ❖

Robert S. De Santo is the chief scientist of DeLeuw, Cather & Company, a consulting organization in East Hartford, Connecticut.

Divorcing Science from the Real World

by Thomas R. Koballa, Jr.

The book before us presents a body of biological facts, and it presents them in a way that most teachers will find familiar, but it does not provide a view of the living world that will prepare students for lives in a scientific and technological society. If a high-school curriculum seeks to relate biology to issues that are personally meaningful to students, and relevant to society at large, this book will not do. It may be useful, though, as a supplementary resource.

The teacher's edition of the textbook differs little from the student's edition. It has a front section that suggests how the book is to be used, and it offers a two-page outline of tactics for teaching each chapter. These outlines, too, lie at the front of the book, rather than being juxtaposed to the corresponding chapters. Typically, the outlines focus on answers to questions posed in the student's edition. Little attention is paid to laboratory safety or to how lessons might be adapted to the needs of slow learners.

The laboratory manual provides some 70 exercises, each related to a chapter in the textbook. Most of these exercises are dissections or "cookbook labs," in which contrived routines verify what the student already has read. Few require data-collection that might extend beyond a 50-minute class period. Generally, the questions accompanying the exercises require only short answers about facts.

The teacher's resource book exists in regional versions: "One for each area of the United States," says Scott,

Foresman's advertising. The company has divined that the areas of the United States are five: West, Southwest, Midwest, Northeast and Southeast. I examined the resource book for the Southwest. Curiously, it has been composed by people from New York, Florida and Colorado. Many of its "regional" activities entail nothing but reading about plants or animals, then answering questions based on the reading. Most of the urban activities seem more suited to upper-elementary or middle-school students than to high-school students. Typical exercises include building a bird-feeder, studying a neighborhood tree, and visiting a botanical garden. The price of the resource book is $93.24.

What are the overall goals of the package that Scott, Foresman has assembled around *Scott, Foresman Biology* 1988? I do not know: No goals are stated in any item that I inspected. Maybe the primary goal is "to provide students with a balance of content and process skill development" — a phrase seen on page T13 of the teacher's edition. If so, there is much discrepancy between Scott, Foresman's notion and the goals that have been articulated by the biology experts who worked on Project Synthesis. (See Paul DeH. Hurd's article in *What Research Says to the Science Teacher*, volume 3, published in 1981 by the National Science Teachers Association.)

Those goals are: "(1) scientific enlightenment; (2) career awareness; (3) the development of cognitive skills (inquiry and decision-making); (4) meeting the adaptive requirements of individual students; and (5) an appreciation of biology in the service of society." They were defined, in part, to take account of new technologies for research (e.g., recombinant DNA), new interdisciplinary perspectives, and new interactions between science and other human activities. Many of those interactions transcend science and demand social, ethical or moral choices.

Scott, Foresman's materials, however, present biology in a context without values. The writers organize information within the structure of biology alone. Some isolated features called "Issues in Biology" or "Breakthroughs in Biology" are their only attempts to relate biology to the student and to society, and the attempts are feeble. To present biology in this way, virtually divorced from real-world concerns, is indefensible — the more so because a biology course will be the last science course that most students will take.

The intellectual skills of biological inquiry are not conspicuous in Scott, Foresman's program, nor is any serious effort to develop awareness of careers. Glimpses of jobs related to biology are confined to ten "Focus on Careers" features; these seem to be afterthoughts. Career information seems to be quite absent from all the other material presented to the student or the teacher.

The writers only rarely suggest that scientific discoveries proceed from the use of evidence and reason. Instead, they present biology as a body of absolute facts that have no defined origin and no historical context. The paucity of historical information is underscored when they actually try to tell about the origin of Mendelian genetics. For some reason, an acknowledgment of Gregor Mendel has become an odd fixture in our biology books, and the same information has been copied, cloned and recloned for the past 30 years. It is flawed and misleading, but here it is again:

Pages 150 through 155 present a tale suggesting that Mendel found and declared the laws of dominance, of segregation, and of independent assortment. (Wrong. Those laws emerged only when other scientists elaborated and clarified Mendel's work.) On page 154 we see: "Mendel found that each trait had a dominant and a recessive form." (Wrong. Mendel's paper of 1865 mentioned observations of flowering time, a trait showing incomplete dominance.) On page 155 we read about pea seeds that "nearly fell into a 9:3:3:1 ratio... as Mendel had predicted." (Wrong. Mendel never mentioned that ratio. Pondering the results of a dihybrid cross, he judged that they conformed best to 1:2:4.) Scott, Foresman's writers should read "Some Myths about Mendel's Experiments," by Alain Coros and Floyd Monaghan, in *American Biology Teacher* for April 1985.

Scott, Foresman Biology 1988 is not a respectable effort and is not acceptable as a high-school textbook. ❖

Thomas R. Koballa, Jr., is an associate professor in the Science Education Center, University of Texas at Austin.

Stuck in the Nineteenth Century

by Martin K. Nickels

My motivation to review a high-school biology text lies in my increasing concern for the biological background that college freshmen and sophomores bring to my introductory course in physical anthropology. Admittedly I do not encounter their knowledge of cell structure, fungi, arthropods or flowers, but I do have to contend with their deficient understanding of two of the most profound discoveries of the last 200 years: Organisms have evolved through immense periods of time, and humans are as much a part of the natural world as are any other organisms.

What I have found, in some 13 years of teaching, is that students entering college are burdened by widespread ignorance and amazing misunderstanding of these two concepts. Most cannot distinguish evolution from selection. Many are unable to explain the difference between Darwinian and Lamarckian models of evolution. Few know anything about

human evolution, and almost none can explain why humans more nearly resemble the other primates than any other organisms on this planet. I do not think that these are petty or esoteric matters. They are among the most important components of our modern understanding of human nature. Every high-school graduate should know of them.

Are my students unusual in having poor backgrounds in biology? Are they ignorant and misinformed because they never have been introduced to the study of living things? No. Like some 80 percent of our high-school graduates, virtually all my students have taken high-school biology. What then is the problem? Very simply, it is that the two discoveries with which I am especially concerned are not being covered at all, or are being covered only superficially and poorly.

The structure and content of high-school courses are strongly influenced by textbooks, and so are the impressions acquired by students. For this reason, I examined the teacher's edition of *Scott, Foresman Biology* 1988 with special attention to its presentation of biological evolution in general and human evolution in particular. I shall concentrate here on the book's treatment of humans.

I was surprised to see that the writers have given an entire chapter — indeed, the second chapter in the book — to the biological attributes of humans. My surprise turned to disappointment, however, when I examined the chapter closely. The writers correctly present humans as primates, but they offer (on page 34) only an extremely short list of the primates' shared features: "stereovision," an opposable thumb, a rotating forearm, and a complex brain. The depth-perception associated with stereovision is noted, but the writers do not tell that it is an adaptation to the arboreal habitat in which primates, as a group, evolved. In fact, they do not describe any of the cited features as an evolutionary adaptation to anything. Why do they leave the student to think that these features exist for no particular reason?

In devising their inexplicably short list of primate attributes, the writers have not mentioned that the digits of primates bear nails instead of claws; they have not told that all primates except humans have an opposable big toe; they have not described the primate reproductive pattern (a single offspring and an intense mother-infant relationship), nor have they told how this pattern promotes the survival of primate infants. These are serious omissions.

On pages 36 and 37, the writers go on to compare humans and gorillas in some detail, but they tend to emphasize differences while excluding many striking similarities. The result is misleading. The student does not learn that both species have the same number and type of teeth; both show the same shoulder-girdle anatomy (which enables them to hang vertically by their arms); both lack external tails; both have feet that are the most supportive, among primates, of the upper body; and both show dramatic chromosomal and biochemical similarities.

By presenting humans as primates, the writers have created an ideal opportunity, very early in the book, to introduce the central concept of all modern biology— evolution from common ancestors. Alas, they do not seize that opportunity, nor do they ever really develop the theme of shared ancestry anywhere in the text. Instead, they seem to strive to avoid it, even if their work becomes misleading. Look, for example, at the note on page 37: "The position of the foramen magnum .. accounts for the difference in posture between apes and humans." This is misleading, confusing and wrong. The position of the foramen *reflects* the difference in posture but does not, in any sense, *explain* it. The difference in posture between apes and humans can be explained as a divergent adaptation to different habitats.

Physical variation in modern humans is covered only in a two-page laboratory exercise, on pages 38 and 39, that deals with measuring various body parts. Why have the writers ignored the opportunity to consider the nature and evolutionary significance of skin color, surely one of the most obvious traits of humans? The book does not even tell that skin-color differences result from differences in melanin pigmentation. The word *melanin* does not appear in the index or the glossary. Am I really asking too much when I expect that something as important as skin color in humans should get as much treatment as sex-determination in reptiles (page 487)? I think not. Moreover, the ignoring of something as interesting as the student's own color is symptomatic of Scott, Foresman's overall obliviousness to the origin and adaptive variation of the student's own species.

It is a shame that the animals that most students find most interesting—themselves—are not used to illustrate and explain the most dramatic of biological processes: evolution. It is ironic that Scott, Foresman's book, which has "Challenge!" questions scattered throughout it, fails to challenge students to reflect on their own natural history. If one judges by this book, the amazing array of hominid fossils that have been unearthed during the past 25 years, as well as the startling biochemical similarities of humans to the other hominoids, have not been discovered at all.

Can Scott, Foresman truly expect to convince educators that this book has "content that's complete, up-to-date, relevant to students ...," as the advertising on page T6 says? If so, I can understand why my own students enter college so ignorant of the place that humans occupy in nature. I hope that other texts are not as anachronistic as this one is.

Scott, Foresman Biology 1988 continues the recent trend by which some publishers produce textbooks that are just catalogs of facts, generally unrelated to one another and unconnected by any conceptual integration. For that reason, and because it persists in conveying an early-nineteenth-century view of humans, I cannot recommend it for use in late-twentieth-century biology courses. ❖

Martin K. Nickels is an associate professor of anthropology at Illinois State University (Normal, Illinois).

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BOOKWATCH

A CANDID REVIEW OF SCIENCE TEXTBOOKS

IN THIS ISSUE:

three reviews of *Heath Life Science* 1987 teacher's edition ISBN = 0-669-11366-2
D.C. Heath and Company, 125 Spring Street, Lexington, Massachusetts 02173

Lost Integrity Maybe you already know about the middle-school textbook *Heath Life Science* 1987. The biologist Stephen Jay Gould gave a long paragraph to it when he wrote about science texts for the January issue of *Natural History*, and he caught its essence in one apt phrase: "lost integrity in education."

Our own reviewers find Heath's book to be inept, misleading and often irrelevant to either life or science. As the review by Ragland indicates, a person familiar with science may have difficulty in taking the book seriously. It surely merits something more than a laugh, however: It merits the telling of its story. The story involves events that took place in California about two years ago, and it will interest anyone who cares about education and students and integrity.

Heath Life Science 1987 has a redesigned title page and some other minor novelties, but it is essentially the same as *Heath Life Science* 1984, which Heath submitted during California's science-text adoption of 1985. That adoption made headlines when California's Board of Education ruled that no middle-school texts would be accepted unless publishers strengthened their treatment of topics that had been muffled or ignored. The foremost topic, in terms of attention paid by the press and the public, was organic evolution.

Most publishers made only minimal changes; and when they offered their "revised" books, in November 1985, their passages about evolution and the history of life were generally as weak, obscure and craven as they had been at the outset. Only after some scientists learned of the "revised" books, and then made their disgust known publicly, was the stage set for real improvement. The scientists told that most of the books were still shameful, and they cited examples. One was *Heath Life Science* 1984, which said (among other things) that the history of the dinosaurs was merely something in which "some scientists believe." That item was quoted in various news reports. In December, the Board said that the books should undergo further revision; and *that* work was done with advice from people who knew some science. The California version of *Heath Life Science* 1984, delivered in February 1986, showed great gains in accuracy, clarity and currency. In *Heath Life Science* 1987, however, Heath has perpetuated the original version of its 1984 book, with all its error, obscurity and anachronism.

William J. Bennetta, Editor

A Toy and a Tragedy
by Lawrence W. Swan

The teacher's edition of *Heath Life Science* 1987 is, in effect, two volumes. One is a reproduction of the student's edition, the other a collection of notes giving suggestions and correct answers to the teacher. There is also an extended introduction that tells the teacher about the qualities of Heath's product. It says that the book reflects requests and recommendations by countless teachers. It tells of "teaching support at your fingertips" and "step-by-step lesson plans," and of how this approach "fosters scientific inquiry." It speaks of "mathematics skills" and "laboratory skills" and "research/reference skills." It says that the book not only covers all the topics of life science but covers them "completely." It says, "A team of highly trained experts — specialists in various fields of life science — have checked and double-checked every page of Heath's student text."

I might imagine, then, that Heath has produced the ultimate life-science text. Everything is supplied, printed in red or blue or green. Colored dots and lines cover the pages. I can even get "parent involvement sheets." Here is organization! Here is gift-wrapped knowledge! And yet, somewhere down inside, I get the feeling that this may be the ultimate text only for somebody who wants an elaborate toy and who does not care enough about science education.

The title page lists three "authors," then four Ph.D.s and an M.D. who are "content consultants." The copyright page shows six "teacher consultants," five "series consultants," and some three dozen "field test teachers." This regiment has assembled 536 pages and more than 1,000 illustrations in color. We are looking at big money, with plenty of airline tickets and fancy dinners. But Heath presumably knows how to make such spending pay off.

How can I begin to analyze this product of so many talented people? How can I lay my body down before such a Juggernaut? Let me begin with a quibble. For any new word in the text, a pronunciation is spelled out. But who, in Heaven's name, pronounces *population* as "pahp-yuh-LAY-shuhn" or *botanist* as "BAHT-n-ihst"? These are not exceptional; the text is full of odd pronunciations, and I find it maddening.

I must hurry now to say some good things. I commend the use of such words as *uterus* (rather than *womb*) and

atrium (instead of *auricle*). I praise the suggestions that teachers should use maps of the world. This may engender the only global-geography instruction that some students will get. I commend the activities that, often enough, rise above busy work to approach education. If teachers enlist those activities, classes will have guests, demonstrations, cluttered bulletin boards and lots of dissected copies of *National Geographic*, and students may learn something.

Heath's book is far, however, from the perfect product that Heath would have teachers believe it to be. For one thing, it is loaded with errors, misleading omissions and confusing inconsistencies. The "monkey" on page T299 is not a monkey but a lemur. The map on page T305 wrongly shows the range of the American opossum extending to northernmost Alaska; it also shows both monotremes and marsupials in New Zealand, though New Zealand has neither. A caption on page T313 tells that a baby gull, when hungry, pecks at the red spot on its parent's bill. What red spot? The picture shows none. The special behavior of *some* gulls has been turned into a false generalization about all gulls, and when the picture refuses to cooperate, the student must somehow believe the generalization anyway. On page T275 we read that the largest lizard is the "dragon lizard of Asia." That is a concocted title for the huge monitor that is commonly known as the Komodo dragon. Having spurned the animal's conventional name, the writers ensure confusion by illustrating what they call a "dragon lizard" from *Australia*. This pictured reptile has nothing to do with the Komodo dragon; it is not even a monitor.

There are many other wrong or misleading items, and I wonder: If they are so obvious to me, how did they elude all those specialists who "double-checked every page"?

In the introduction telling how Heath's book has every whistle and bell, page A-7 says that the book seeks "to foster an awareness of the increasing complexity of the organisms in the five kingdoms." Increasing complexity? That is one aspect of the grand process that pervades the whole story of life on Earth: organic evolution. Evolution is the heart of biology — the glue for binding facts, the light for reasoning — but Heath's writers shun and conceal this unifying theme. Yes, there is chapter 20, called "Changes Over Time," but it is silly. The writers compare the ideas of Lamarck and Darwin, but they do not do it with any great legitimacy. They do not point out that Lamarck's effort embodied his recognition that nature did not comply with biblical beliefs about fixed species. They say, "Today most scientists agree with Darwin's explanation." The implication that other scientists agree with Lamarck is ludicrous, and that word "today" is incongruous. According to Heath, the last identifiable person who thought anything about evolution was Hugo De Vries, circa 1901.

Instead of informing the student that the whole of life's history has been one of evolution, Heath's writers suggest that life may not even have a history. On page T402, fossilized palm trees "are believed" to have lived 80 million years ago. On page T401, fossil-bearing rocks "are thought" to be 270 million years old. On page T399, the dinosaur *Tyrannosaurus* "is believed" to have lived more than 130 million years ago. (That one is a double whammy, for the wording is misleading and the date is wrong. About 70 million years would be accurate.) The ages of fossils are plain facts of science, but the writers deny them.

The sins of omission are even more severe. There is no diagram of relationship: no branching tree to show that mammals arose from reptiles, or that birds still have scales on their legs and show their reptilian origins. There is no suggestion that amphibians evolved from fishes, so students cannot understand why a typical tadpole looks and behaves like a fish. There is no geological time scale in the section on fossils. The writers mention lampreys, but they do not tell that these jawless animals lack an appendicular skeleton or true teeth. Then they jump to sharks, but they say nothing about the derivation of enameled teeth from enameled scales, or about the origin of a jaw from a gill arch. They say a little about the mammalian embryo (which all of Heath's "experts" have confused with pre-reptilian embryos) but they do not tell that mammalian development reflects a great evolutionary invention: the reptilian egg. On page T418, they ask students to compare the human skeleton with that of — what? A frog? A cat? No. An arthropod! And so the writers abandon the chance to introduce the evolutionary concept of homologous bones. They seem to insist that they must give no hint at all of any evolutionary relationships.

I wonder what guided the minds of all those "experts." There seems to be only one credible answer: They seem to have been interested not in science education but in the extra money that they might get by kneeling to the Bible Belt.

There was a tragedy in the production of *Heath Life Science* 1987, and it involved some of those people listed on the title page — the ones who have academic affiliations that imply knowledge of science and dedication to its principles. To the extent that they may knowingly have lent their names to dignifying Heath's product, they have betrayed science for some pieces of silver. ❖

Lawrence W. Swan is a professor of biology at San Francisco State University.

Something to Remember

by David R. Stronck

Studies by the National Science Foundation have shown that many science teachers rely totally on textbooks to define curricula and courses. In the hands of weak teachers, *Heath Life Science* 1987 can do much damage. It is an easy formula, I fear, for the kind of course that has turned a multitude of middle-school students away from science.

A good teacher tries to select topics that meet the needs and interests of students, and then tries to present those topics in ways that yield understanding. Heath's writers, however, seem to be concerned only with saying a little something about almost every biological topic, and with devising tests that emphasize memorization and recall.

The teacher's edition of Heath's book begins with a long, colorful advertisement, and page A-6 of the ad says that Heath's program promotes "five categories of vital skills" named "Reading Comprehension, Word, Mathematics, Laboratory, and Reference/Research." My analysis of the

textbook and of the accompanying *Computer Test Bank* shows that the first two categories — reading and vocabulary — are emphasized heavily, while the others get little attention. The tests in the bank could be used even if students performed no laboratory activities at all.

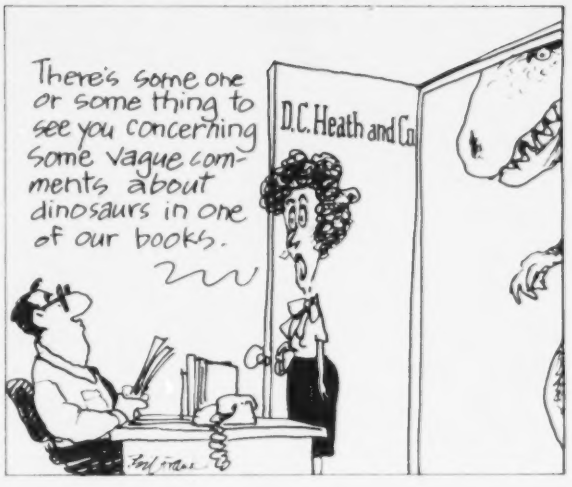
On page iv of the *Computer Test Bank*, we read: "Approximately 60 percent of the items are at the recall level. These questions involve recall of facts and definitions presented in the text. Approximately 40 percent of the items test students at the inferential level. These items require students to interpret questions in light of information presented in the chapters." Then, throughout the bank, each item is labeled as either "recall" or "inferential." The distinction, however, seems to be arbitrary or meaningless.

An item in the test for chapter 19 ("Genetics") says: "The number of possible combinations for gene pairs in a Punnett Square is [*answer*: four]." The writers label that as a "recall" question. On the other hand, they give the label "inferential" to this: "Before the end of mitosis, the [*answer*: DNA] within the parent cell must copy itself." In the test for chapter 1 ("Introducing Life Science"), they apply "inferential" to this: "A statement of a hypothesis that has been upheld by experimentation is called a [*answer*: theory]." A "recall" item in the test for chapter 1 says: "The most basic skill of a scientist is [*answer*: observing]." My own observing shows that very few questions really require inference. Most questions, regardless of labels, test vocabulary development; the rest emphasize reading comprehension.

Heath's advertisement says that the book covers topics "completely" and with "enough depth and enough detail to tell the whole story." Yet many stories are far from whole and are so brief that they create more confusion than learning. Such stories are conspicuous in chapter 25, "Health and Environment," the last chapter in the book. The very placement of the chapter is distressing. Although many educators have urged that health topics should be major themes in life-science courses, Heath's writers ignore those topics for 500 pages. Then, in 14 pages, they try quickly to touch on everything from infection and vaccines to drugs and nutrition. This is irresponsible, and a teacher may not even get to the last chapter before the school-year ends.

The writers dispose of nutrition in eight paragraphs. Their only recommendation about food-selection is that students should eat a variety of items from the "Basic Four Food Groups." They do not mention the federal *Dietary Guidelines for Americans*. They do not even explain that Americans typically eat unhealthfully large amounts of dairy products and red meats, and that these are the chief sources of excessive fat in our national diet.

Heath's material about drugs consistently fails to give adequate descriptions of the harmful effects of those substances. The writers say that taking amphetamines for thrills "can lead to physical dependence"; they do not mention death. They say that a person who smokes marijuana "may have trouble thinking and take longer to react"; they say nothing about brain damage. They dismiss alcohol with some notes about slurred speech, blurred vision and passing out; they say nothing about lethality or about the lives and deaths of alcoholics. They casually relate cigarettes to


There's some one or some thing to see you concerning some vague comments about dinosaurs in one of our books.
D.C. Heath and Co

cancer and heart disease, but they do not even hint at the annual rate of premature deaths due to cigarette-smoking.

Chapter 18 is called "Reproduction and Development," and it nominally emphasizes humans. It has a diagram of the reproductive system in each sex, with a bit of text about testes and ovaries and so forth, but it does not suggest where these things may be found. A female student does not learn what her vagina is, because Heath says only "birth canal." The male student is kept ignorant too: The word *penis* never is used, and Heath's picture shows the male urethra hanging in space, with nothing around it! The term *sexual intercourse* is shunned, and Heath's closest approach to coitus is one sentence on page T363: "When sperm are released in the female's body, they swim up through a hollow, muscular organ called the uterus and into the oviduct."

In the advertising on page A-7, a "content rationale" says that one of the book's goals "is to foster an awareness of the increasing complexity of the organisms in the five kingdoms." This of course would require fostering an awareness of evolution, the great concept that organizes all aspects of today's biology; and any reader of the "content rationale" would expect a strong emphasis on evolution. That expectation would be false, however, for Heath actually has isolated evolution in chapter 20 — another late chapter that easily can be omitted by a teacher pressed for time.

In earlier chapters, references to the history of life are obscure. In the chapter about ectothermic vertebrates, for instance: "Some scientists believe that strange animals with dry, scaly skins roamed the earth 225 million to 65 million years ago. These animals were the dinosaurs." *Some* scientists? The only people who deny the history of the ancient dinosaurs are the fundamentalist preachers (and their followers) who call themselves "creation-scientists," but those people are not scientists at all. In chapter 20 itself, the writers consistently minimize evolution by saying things like: "Many fossils resemble no living plant or animal, indicating that some organisms have become extinct." That is scarcely the whole story. Students should know that more than 90 percent of all fossils represent extinct species, and that more than 90 percent of the species that ever have lived have become extinct. How has Heath managed to publish so many inaccurate and misleading statements? The advertis-

ing on page A-5 says "highly trained experts ... have checked and double-checked every page of Heath's student text."

Heath Life Science 1987 is a formula for superficial tasks of memorization, and it avoids or blurs or trivializes topics that are directly relevant and important to the students' own lives and health. It should not be adopted. ❖

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Mr. Big and the Magic Ladder

by Thomas E. Ragland

I am writing this because I perceive a danger that *Heath Life Science* 1987 might really be adopted by some unsuspecting and uncritical school district, and that students might be subjected to its egregious errors and nonsense. If that danger did not exist, I would simply dismiss Heath's book with a laugh, for it is laughably inadequate.

The book's outstanding feature is its anthropocentricity. Its message is: "Man is the only important or interesting thing in the living world. All those other organisms are just decorations that surround him." There is hardly any suggestion that anyone might find intellectual fulfillment in studying other organisms for their own sake, rather than studying them for their effects on Mr. Big. Heath's writers thus promote the ancient, wrong-headed notion of a ladder of life — a *scala naturae* — that has a man on its top rung. That notion has nothing to do with science. Scientists rejected it long ago, because it obviously did not reflect or explain nature, but Heath's writers remain devoted to it. One prominent sign of their devotion is their brief, extremely oversimplified treatment of plants. They give fewer than 50 pages to plants as such, but they give some 150 pages to animals other than Mr. Big, and nearly 100 to Mr. Big himself.

The organization of the book is inexcusably bad. For example: The writers take their first stab at ecology in chapter 5 ("Environment and Life"), before they have introduced any taxa beyond protists, monerans and fungi; but chapter 5 itself deals largely with metazoans. They offer some related material in chapter 8 ("Ecology"), after they have taken their brief look at plants, though they still have not considered any metazoans. More such material appears in chapter 13 ("Water Ecosystems") and still more shows up in chapter 17 ("Protecting the Environment").

Scattered through the book are one-page diversions titled "Science and Technology." They mislead the student into thinking that science and technology are the same thing, they project a wholly wrong view of the goals of scientific research, and they promote the fancy that organisms are important only to the extent that they are useful to humans. Example: The "Science and Technology" page subtitled "Using Insect Models" alludes to studies of how insects fly, but its real theme is engineering. It concludes, "By studying how insects land and control their flight patterns, scientists hope to improve the construction of planes and helicopters." The writers do not suggest that science might be fun, that scientists might study how insects fly because they want to know how insects fly, or that scientists seek anything beyond the learning of some commercial tricks.

The student who uses a science text will consult its glossary and index frequently. In Heath's book, the index is minimally satisfactory, but the glossary is inadequate and sometimes ridiculous. It sometimes seems to be a lampoon written by Dr. Science and Rodney, National Public Radio's parodists of science and technology: "**abdomen:** the body region of arthropods that is farthest from the head ['Gee, Dr. Science, my uncle just had abdominal surgery. What was *that* all about?'] ... **bacteria:** the group of monerans that are found almost everywhere ['Look at these monerans, Dr. Science. Are they bacteria?' 'I don't know, Rodney. I'll activate my network of agents and tell them to start looking around.'] ... **jawless fish:** a class of fish that do not have jaws ['Wow, Dr. Science! I knew that one even before you told me.'] ... **birds:** warm-blooded vertebrates with wings ['And so much for those eggheads who think that bats are mammals.'] ... **species:** the smallest classification of living things ['But how small *is* it, Dr. Science?' 'In science-talk, Rodney, ten centimeters by five.'] ... **identifying:** the naming of something ['Hey, Dr. Science, have you identified that bird from Fiji?' 'Yes, Rodney, I identified it Louise.']"

Careful reading of the teacher's edition shows that material for the teacher is as chuckle-headed as material for the student. The pedagogic notes are written not in English but in ed-jive, and some "correct" answers to questions are downright stupid. On page T236 the teacher finds: "A dragonfly can see better [than a spider can] because it has two large compound eyes that can detect images as well as light. Spiders have simple eyes that can only detect light." (How can jumping spiders find prey or see their mates' nuptial dances if they cannot perceive images? And if images cannot be formed by simple eyes, like mine, how can I read these words?) On page T503, a lesson plan suggests inviting a policeman to visit the class to "discuss the various types of drugs." Because Heath's writers treat drugs in an utterly frivolous way, the teacher will have to invite *somebody* if the students are to receive real information. But why a policeman instead of a physician or pharmacologist?

To sum up: I would not have tried to take Heath's book seriously if I did not fear that some school district might adopt it and inflict it on students. No student deserves such cruel treatment. If you have a copy of the book, use it for a paperweight. Just keep it away from any young person who might want to learn about life or science. ❖

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BOOKWATCH

A CANDID REVIEW OF SCIENCE TEXTBOOKS

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IN THIS ISSUE:

three reviews of *Prentice-Hall Biology 1987* teacher's edition ISBN = 0-13-700378-1
Prentice-Hall, Inc., Route 9W, Englewood Cliffs, New Jersey 07632

Boring and Baffling Our Tenth-Graders

by Colin O. Hermans

Prentice-Hall's biology book is nice-looking. The cover has a colored photograph of a tiger in pretty vegetation, and there are many colored illustrations inside, and there is even a blue ribbon to serve as a bookmark. The book is big, too. The teacher's edition has more than 1,000 pages, weighs more than four pounds, and contains much more information than students will be able to learn in one school-year. A teacher will have difficulty in using it to give a well balanced course, because major sections of the text will have to be skipped. If any teacher tries to get through the whole book, the result will consist not of teaching but of hastily shoving information down students' throats. A lot of students will quickly learn to hate biology.

There are other serious defects. While the book presents many important facts and seems to cover important topics, it is filled with the smarmy rationality and shallow wisdom that drive students crazy. Moreover, a lot of what it offers is incomprehensible or simply wrong. It abounds with material that seems alright at first glance but cannot survive careful reading. When inspected closely, it signals that the writers do not understand what they are writing about.

The text is divided into ten units: "Introduction to Biology; Cells; Variety and Continuity; Microbes; Plants and Fungi; Invertebrates; Vertebrates; Human Structure and Function; Human Response and Development; Ecological Interactions." Each unit has about five chapters.

The first unit announces many shortcomings that will recur throughout the book. It opens with a gorgeous photograph of ducks taking off from a lake. Good! It seems to say that biology can be beautiful. This hope is quickly dashed by the caption: "Like all birds, mallards have unique characteristics such as feathers. Mallards also have characteristics that they share with other organisms such as the presence of limbs." Biology is not beautiful after all: It is *boring*.

The unit's first chapter — "What Is Biology?" — has pictures that seem to reflect a grotesque effort to say that biology is for everyone. A caption tells that scientists need to gather information; the picture shows a model posed as a scientist using a library; the model is a woman in a wheel chair. A caption tells that scientists use computers; the computer-using model in the picture is a young woman who looks Asian. A "Career" note tells about biology teachers; in the picture, one of the three models is a woman with a black patch on her left eye. A caption tells that biologists learn from experiments; in the picture, reminiscent of tooth-paste-ad scientism, the model is a young, African-looking man who gazes into a separatory funnel. There are only two pictures of real scientists: Pasteur and Morgan; two old fogies who look European. The scientific community apparently has undergone a big change since their day.

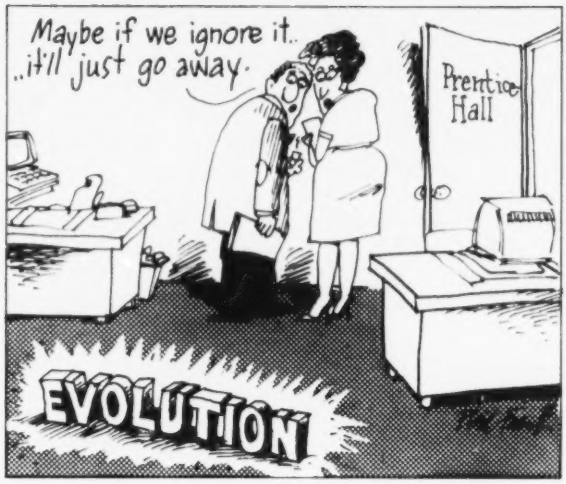
The change may have been salutary, for the achievements of the great biologists of the past were evidently trivial. Darwin? He published a book that "discussed a theory of evolution .... Among other things, his theory explains that organisms with slight advantages over other organisms have a greater chance of survival." I am not fooling you. Prentice-Hall's book really says that. Mendel? He "grew pea plants to see how the offspring resembled their parents."

Just Imagine Imagine a history text that did not tell that historians try to identify the social and economic forces that have shaped historical events. Imagine a chemistry text that ignored reaction mechanisms; imagine a text saying that chemists simply classify reactions by the colors of the products that are generated — red reactions, green reactions, and so on. Those imaginary books would resemble most of the real books that now are being sold to high schools as biology texts. The books ostensibly use biological classification as a major theme, but they do not tell what it is about. They do not tell that taxonomy revolves around phylogeny and that classification is an attempt to describe evolutionary relationships. Instead, they lead students to think that it is an inane exercise in sorting redsies from greensies.

Prentice-Hall's book is such a product, and our first review shows how far Prentice-Hall's writers have gone in the propagation of nonsense: They have not merely ignored the evolutionary basis of classification; they have offered statements about classification that are absolutely false.

Now imagine one more thing. Imagine what might happen if schools started refusing to buy "biology" books that ignore basic biology and dispense plain rubbish.

William V. Mayer, Editor-in-Chief
William J. Bennetta, Editor



The first chapter also touches on "the scientific method" and the tools of scientific research. Concerning the light microscope, the writers say: "Unfortunately, the more an image is magnified, the poorer is its resolution." Intelligent tenth-graders, if still awake, wonder why anyone would employ such a device. The writers do not tell. Instead, they rush to mention electron microscopes, saying that the first ones "were used in 1931." Our tenth-graders envision biologists studying organisms with electron microscopes in 1931, but they have been misled by 20 or 30 years. The writers then say that "The techniques that are used to prepare the specimen destroy cells." How can there be anything left to observe? The writers do not suggest any answer.

And so it goes. In chapter 2, the writers say that adaptation is one characteristic of living things. They fail to explain what that means, however, although they spend three paragraphs in trying. In chapter 3, "Classification of Organisms," they say: "The two words [of a scientific name] describe the characteristics of an organism, or refer to the person who named it or the place where it was found." That is dead wrong, and it has been dead wrong since the time of Linnaeus (1707-1778). It describes a few special cases, but as a generalization, it is wrong and worthless. All that scientific names consistently do is to serve as names.

Chapter 3 has a defect much worse than that one, however, for it absolutely fails to deal with the concept of species. Species are the things that have evolved to produce the organic world that we now study. One can argue that the species is the fundamental level of biological organization, and that the concept of species is crucial in biological thinking. Biology without species is like physics without atoms, but Prentice-Hall's writers ignore them.

Why? Is this one of those books that strive to keep organic evolution a secret? A casual inspection suggests that the answer is *no*. The "Variety and Continuity" unit has three chapters that seem to deal with aspects of evolution — chapters called "Applications of Genetics," "Variation Through Time" and "Human History." Careful reading, however, shows that the answer perhaps is *yes*. The writers avoid the term *evolution* in favor of the ambiguous word *development*, thus confusing ontogeny and phylogeny. (*Development* is not a synonym for *evolution*, and such usage is false and misleading.) The "Human History" chapter emphasizes the variety among primates but fails to tell of the evolutionary continuity that unites them all.

The subject of evolution is muted in many other passages as well. On page 45, in the chapter about classification: "Structures that have the same basic pattern and general relationship of their parts are said to be homologous." That is absolutely false. Homologous parts are those that have evolved from the same structure in a common ancestor. This is the only meaning of *homologous* in today's biology. On page 46, the writers say that cats are placed in the order Carnivora because they are chiefly meat-eaters. That is absolutely false. Cats eat meat, but they are placed in the Carnivora because they evolved from the same ancestors that gave rise to the other members of that group — the dogs, the bears, etc. If diet were the big issue in taxonomy, then killer whales and Eskimoes would be in the Carnivora too. Our tenth-graders wonder why that is not the case. Later, when they read about "Classification of Mammals" in the unit about vertebrates, they will wonder why grass-eating horses and grass-eating cows are placed in different orders. Horses' feet differ from cows' feet, as the book tells; but is it not also true that cats' feet differ from dogs' feet? Our students are baffled because the writers have given false statements and have said nothing about the relation between taxonomy and evolution.

The text presents a five-kingdom classification of the living world, but on page 47 of the teacher's edition the writers tell the teacher to explain that "at the kingdom level" *three* groups "contain every kind of organism." They do not say why three kingdoms might be better than five or some other number, or why one system of classification might be better than another. We must not chide our tenth-graders if they conclude that the living world is incomprehensible, and that the way in which scientists regard it is whimsical and meaningless. I do not recommend *Prentice-Hall Biology* for use in high-school biology classes. ❖

Colin O. Hermans is a professor of biology at Sonoma State University (Rohnert Park, California).

A Good Text That Could Be Better

by Arnold M. Clark

I taught general biology for many years to undergraduates (both majors and non-majors) at the University of Delaware. I am familiar with college textbooks in biology, and I know that they provide no information about how that subject should be presented. I was impressed, therefore, to find that the teacher's edition of *Prentice-Hall Biology* 1987 opens with an excellent, 149-page section about pedagogy and teaching strategies. Our university biologists should read it. Although all of them come to the university with a research specialty, few of them come prepared to deal with the first-year biology course. Reading Prentice-Hall's book would give direction to their teaching and would forge a link between secondary-school biology and college biology.

Prentice-Hall Biology 1987 is a good text. There is balance among its ten units, and the essential material is

covered. The illustrations are thoughtful, and the material at the end of each chapter is helpful. A high school would do well to hire a person to set up the experiments that the book suggests, and to develop the research projects. The classroom teacher will have difficulty in finding time for this.

The book offers more material than can be presented (or learned) in one school-year, and teachers will have to choose, in accordance with their own training and goals, which topics to omit. While the organization of the material is impressive, we must recall that students cannot grasp that organization. It can be appreciated only by people who have studied and taught biology for a long time. I wish that the writers had sacrificed some topics so that they could have given more space to helping students toward an understanding of science. Their book presents interesting information in an interesting way, and it reaches out to students, but it does not answer two fundamental questions: *Where does all this biological information come from? And why should we accept it?* Sometime, in some course, we must tell students that science has brought a profound change in our picture of the world and has produced a perception of a mechanical universe, for science attempts to explain the universe in terms of natural laws. It proceeds by challenging its own theories and by correcting its own mistakes, and in this way it continually draws closer to explanations that work.

Students must get a sense of how some of our most important scientific ideas have developed. Examples might include the idea of the circulation of the blood, from the speculations of Galen to the experiments of Harvey; the idea of the gene, from Mendel's observations through our current knowledge of DNA; and the idea of the cell, from the time of Hooke through the time of the electron microscope. Prentice-Hall's book, however, does not tell the history of any of these concepts or of many others that are available.

Chapter 9, "Heredity," includes a presentation of the operon model of gene function. It is not needed and cannot be appreciated by students. The writers might better have used the example of hemoglobin F and hemoglobin A to teach that genes are turned on and off, and that different tissues use different genes to make different proteins. The phenotype of an organism depends not only on structural genes but also on the regulatory genes that determine when, during development, the structural genes will act. We need more emphasis on what genes do, less emphasis on how genes are transmitted. It is time to replace Mendel's dihybrid cross with material about topics such as the genetic load on human populations, the genetics of behavior, and the role and value of genetic counseling.

Chapter 10, "Genes and Chromosomes," would be better if it helped students to understand the biochemical bases of metabolic diseases. If I were teaching from this chapter, I would supplement it with a chart showing the biochemical defects involved in, say, ten such diseases. I would also present a fuller explanation of phenylketonuria and of the screening of infants for signs of that disease, so that I could show some social implications of genetics.

Chapter 12, "Variation Through Time," is about organic evolution. It fails to separate the evidence showing *that* evolution has occurred from the evidence of *how* evolution has occurred. Clear separation is necessary, however, if we are to avoid misleading students into imagining that there is some scientific disagreement over whether evolution is a historical reality. No such disagreement exists. Just as we know that a chick develops from an egg, we know that evolution goes on; but just as we still have much to learn about the mechanisms of development, we have much to learn about the mechanisms of evolution.

It is time for textbook-writers and teachers to marshal some additional examples supporting the concept of evolution. I would suggest the kidneys of vertebrates, the ear bones and jaw bones of reptiles and mammals, the vestigial appendages of whales and pythons, the experiments in which bird tissues have produced teeth, and a good example of biochemical evolution (such as hemoglobin).

And it is time to get rid of Lamarck, the inheritance of acquired characteristics, and those stories about giraffes! Lamarck's notions, discredited long ago by Mendelian genetics, have been discarded by science. There is no need to burden students with them.

Scientific ideas often are involved in controversies — not only controversies among scientists but also controversies between scientists and representatives of other enterprises. Organic evolution is one such idea. Teachers may think that they are simply teaching about an aspect of biology, but some students may think that they are hearing about an alien religion. We must make clear to students that biological evolution is merely one of many concepts that, from time to time, have provoked religionists of one sort or another. We must tell students that some devotees of biblical religion have also rejected the idea that Earth is spherical rather than flat, the idea that Earth revolves around the sun, the idea that Earth is billions of years old, the idea that fossils are the remains of ancient organisms, and so on. Students must grasp how science differs from, and interacts with, other undertakings. Teachers of science must be prepared to teach about controversy and even *within* controversy. If they are unwilling to accept this challenge, they can seek easier employment as teachers of, say, the multiplication tables.

Prentice-Hall's presentation of taxonomy, in chapter 3, happily is not overburdened with scientific names, but it lacks any example showing how and why classification changes. Students must understand how taxonomists seek classifications that reflect evolutionary relationships and common ancestry. This fundamental principle, however, is absent from the book.

Finally: Students cannot understand pedigree analysis, genetic diversity, population genetics or genetic counseling if they do not know something about probability. There is no need to pamper them but much need to teach them. Probability theory provides insights into biology and shows students how biology and mathematics are related parts of their learning experience. As Darwin said, "those people who understand mathematics have an extra sense." ❖

Arnold Clark is a professor of biology, emeritus, from the University of Delaware. He now does writing at the Marine Biological Laboratory in Woods Hole, Massachusetts, and works with science teachers at Falmouth High School.

Out of Step with Science

by Joseph D. Novak

I have a strong bias against the approach taken by most high-school biology books, which strive for superficial coverage of almost all of the traditional topics. Inevitably, the fundamental ideas necessary to an understanding of living systems are buried in an avalanche of detail. This problem is evident in *Prentice-Hall Biology* 1987, right from the outset. On page 32, for example, the writers present the characteristics of living things, but their treatment is brief and shallow. There is little discussion of the uniqueness of living systems or of the extraordinary mechanisms that enable them to capture energy and to use it for growth and reproduction. A student could go through unit after unit of this book, learning new vocabulary and then forgetting much of it, without acquiring any fundamental knowledge of how organisms work or of how the structures and functions of organisms complement each other.

Most biology texts offer a highly misleading view of science and of scientific inquiry, and this too can be seen in Prentice-Hall's product. The writers describe science in terms of the standard six steps of the scientific method, one of which is experimentation. They thus imply that all scientific knowledge springs from experiments, although this clearly is not true in some large domains of biology, such as systematics and ecology. They say nothing about the creativity involved in the designing of scientific inquiries, nor do they tell how the conceptual framework employed in an inquiry affects the kind of results that the inquiry yields.

In some later parts of the book, the writers sporadically mention scientific disagreements about theoretical issues, but they imply that someday we surely shall know The Real Answers. In this way they convey a positivistic view of science and of knowledge, suggesting that there must be correct answers in all cases and that a student's task is to memorize those answers. They almost totally ignore the important roles that human emotions and values play in both the selecting and the answering of research questions. This positivistic image leads to much misunderstanding of science by the public. Because biology is the most popular of high-school science courses, and often the last science course that a student takes, it is unfortunate that biology texts present such an erroneous picture of the nature of science.

Prentice-Hall's unit on cells introduces much chemistry but offers little explanation of how principles of chemistry operate in biological processes. The unit about genetics and evolution promotes misconceptions. The writers deal only briefly with probability, and they repeatedly make misleading statements suggesting that phenotypic ratios are constant and precise. A caption on page 161, for example, says: "In a dihybrid cross, the phenotype ratio is always 9:3:3:1." Nowhere do the writers explain that the ratios seen in real experiments merely approximate the theoretical ratios, and that the approximations may be poor unless the samples are very large. Students may glimpse this fact if they do the exercises in the textbook and the laboratory manual, but the writers make a serious mistake by failing to provide an explicit discussion of probability distributions.

The material about evolution comes so early that, in principle, the writers might have used it as the foundation for later units. They have not done so. In their four-unit survey of organisms, for example, they place major emphasis on classification and on the names of structures associated with various organisms. They give little attention to the principle of homology or to the evolution of structures, except in a reasonably good section called "The History of Birds."

Nowhere in the book is there any substantial discussion of evolutionary processes or phylogenetic principles.

Because the unit on ecology comes last, many one-year courses will never reach it, and many students will never learn about aspects of biology that are especially relevant to their daily lives. Moreover, the decision to reserve ecology until the final unit meant that the role of the environment in shaping evolution could not serve as a major theme in the book as a whole. This presumably is a reason why the survey of organisms focuses on anatomical structures *per se*, rather than on the interplay between structures and surroundings. Biologists say that "ecology is evolution happening," but the student who uses Prentice-Hall's book will not perceive the important principles that this slogan summarizes.

A useful feature of the book is its collection of one-page items called "Issues in Biology." These might stimulate discussion and library work that could breathe life into the book's static presentation of detail. A skillful teacher could even use them for breaking away from the book's positivism and for showing how knowledge grows and changes as new questions are asked. A recognition of how our knowledge evolves will serve students for a lifetime, helping them to understand both the promise and the limitations of science.

The end-of-chapter materials show heavy emphasis on vocabulary. For most students, this will mean memorizing definitions without understanding the relevant concepts.

All in all, Prentice-Hall's book is a reasonably adequate, traditional text for a course that will trade depth for breadth, will present concepts and principles only superficially, and will present biology as hundreds of words to be memorized. If any teachers try to cover all 48 chapters, they rarely will be able to conduct any deep discussion of any idea that the book mentions. Demands imposed by state examinations and other external influences may lead some teachers to accept this course of action, but teachers should recognize that it is widely out of step with our current understanding of learning processes, with our current view of the nature of science, and with our need to help the public to understand science. Students deserve textbooks that are excellent. Prentice-Hall's book falls far short of the mark. ❖

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A CANDID REVIEW OF SCIENCE TEXTBOOKS

IN THIS ISSUE:

three reviews of *Scott, Foresman Life Science* 1987 teacher's edition ISBN = 0-673-42051-5
Scott, Foresman and Company, 1900 East Lake Avenue, Glenview, Illinois 60025

Not Much, Probably Not, and No

by David L. Edwards

While I examined *Scott, Foresman Life Science* 1987, I asked myself what my 13-year-old daughter would learn if her school used this book as an introduction to the study of living things. My answer is: Not much. I also asked myself whether she would become excited about biology. Would she sense the intellectual satisfaction that it offers, or the great practical rewards that it can provide to her and to society as a whole? My answer is: Probably not.

I doubt that many 13-year-olds will be excited by such mind-numbing phrases as "Life science can make your life more interesting." Scott, Foresman's writers offer that one on page 7, in a passage called "Applying Life Science to Your Life." They tell that "life scientists" have learned of "tiny organisms" and so have made possible the combatting of some diseases — something known to every young person who has a television set. They say that knowing about organisms can be handy when one takes a walk in the forest. Finally, they say that the study of life science can lead to rewarding careers. They support that last point with a single example that is eccentric: A detective works in a laboratory and "needs to know a lot about life science" so that she can use blood samples and hairs for identifying people.

Material like that may convince a few 13-year-olds that life science can make their lives interesting, but it will not convince many. It surely will not convey where the study of living things stands today, or the excitement that suffuses so many branches of biology.

Scott, Foresman's book is — to use a favorite word among middle-school students — boring. This is the most disturbing thing about it. I certainly am troubled by its many misstatements and its muddiness, but I am troubled even more by its dullness. The biological sciences have entered into a new golden age: On every side, the frontiers of our knowledge are expanding rapidly. A major task for any introductory text is to furnish its readers with a sense of excitement about what is happening, but all of that is missing from this book. The writers seem to have adopted a defensive posture, trying to produce something that will not offend anyone, of any persuasion. They nearly have succeeded. I do not think that the book will offend anyone but those who expect that students actually will learn something.

Chapter 1 begins with a muddy, confusing attempt to describe living things and to differentiate them from non-living ones. The writers spend a page and a half in mentioning various objects, from clouds and airplanes to blueberry bushes and hummingbirds, but nowhere do they give a plain statement of the point that (I think) they are trying to make: Living things exhibit growth, response to environment, energy-consumption, and reproduction; non-living things may show *some* of those properties but not *all* of them.

Along with poor writing, chapter 1 introduces the use of amateurish artwork in places that demand respectable drawings or photographs. Sketches and cartoons can have legitimate roles in science books, but Scott, Foresman uses them in gross excess and conveys the message "This is comic-book stuff, and it need not be taken seriously." My favorite example, among many, is the colored sketch on page 202:

The Unicorn Squad Scott, Foresman's life-science book is sold for use in middle schools. It apparently has been written by people who think that the unicorn is a real animal, who think that Greek and Latin are the same thing, who think that a species has "permanent characteristics," who do not know what science seeks to do, and who see no importance in things such as AIDS or genetic engineering.

Our reviewers tell more about the work of this squad, and Ghiselin offers his opinion that the adoption of *Scott, Foresman Life Science* 1987 by a public-education agency could be challenged on constitutional grounds. All that we shall do here is to list the unicorn squad's members — the "authors" shown on the title page of Scott, Foresman's book: **LeVon Balzer** ("Dean of Arts and Sciences, Seattle Pacific University"), **Phyllis L. Goodson** ("Biology Teacher and Vice Coordinator" at the Percy Julian High School in Chicago), **Irwin L. Slesnick** ("Professor of Biology, Western Washington University"), **Lois Lauer** (a "Former Science Teacher" in Darien, Illinois), **Ann Collins** (a "Former Life Science Teacher" in Cambridge, Massachusetts), and **Gretchen M. Alexander** ("Program Coordinator, Museum of Science and Industry, Chicago, Illinois").

Those people wrote the book, says the title page.

William V. Mayer, Editor-in-Chief
William J. Bennetta, Editor

"Frog in hibernation." The sketch is shoddy, and what it shows is silly. Mr. Frog, with mouth open, crouches in soil near a partly frozen pond. He is very close to the soil's surface, and he is doomed: Even if nobody steps on him, he soon will freeze solid.

Starting on page 10, the writers do a four-paragraph routine about "the scientific method." It falls far short of the mark and cannot provide any student with an idea of what science is about. The writers drop words like *hypothesis* and *data*, but they cite no actual example of scientific work. Instead, they offer an implausible fable in which some students investigate the "conditioning" effect of jogging. The worst aspect of the passage, however, is that it fails to tell that after scientists hypothesize and experiment, they establish facts about nature. They establish that, yes, Earth *does* move around the sun; and yes, yellow fever *is* spread by mosquitoes; and yes, DNA *is* the genetic material. Scott, Foresman's writers apparently do not know that the goal of science is to explain the natural world, and they apparently do not know (or, at least, do not want to tell) that science continually grows by building on itself. Newly discovered facts are used for generating new hypotheses and planning new experiments, which in turn yield more facts; and so on. Real science is a living enterprise, but Scott, Foresman's notion of science is a dead end.

On page 24 the writers start a description of cell structure, and page 25 has a colored sketch in which various parts of a cell are labeled: nucleus, nuclear membrane, cytoplasm, ribosome, etc. This will mean little to students, because the writers have not prepared them to understand it. It will be hard for students to appreciate a ribosome, for example, because they have not yet seen anything about proteins. And the writers only make things worse when, in the nearby text, they try to circumvent proteins by using the inane term *building blocks*: "The actual building blocks of the cell are made on the surfaces of these very tiny structures [ribosomes]." Proteins appear for the first time on page 31, where they get two sentences and are described only as "large molecules." The writers do not tell that these are the items that were "building blocks" on page 25. To make things still worse, they never again refer to ribosomes.

The writers seem to be preoccupied with reciting terms in some mysterious order, rather than in conveying and relating concepts. When I think of students burdened with Scott, Foresman's product, I see them struggling mightily to memorize a bunch of big words that generally are incomprehensible to them.

The central portion of the book provides a pedestrian look at various forms of life, and the final portion deals chiefly with human physiology. In the latter context, the writers appropriately give some attention to drugs and drug-abuse, but their effort is unsatisfactory. I see the street names of various drugs (such as *speed* for methedrine), but nowhere do I see the words *addict* and *addiction* or any serious effort to describe the consequences of abuse. Here is the entire passage about heroin: "The illegal drug heroin, nicknamed 'smack' or 'horse,' is not even used medically in the United States. People who become physically dependent on heroin may take six months to withdraw from it." Do the writers really not know what heroin does to people? Do they really think that escape from heroin addiction is common, and that it is noteworthy only because it may take a few months?

The editors of *Bookwatch* have asked me whether Scott, Foresman's book is current . My answer is: No. Where is genetic engineering? Where is AIDS? Where is embryo-transplantation? Where, for that matter, is the drug called "crack"? All those subjects were prominent in news reports long before the book was produced, and all are prominent today, but the book ignores them entirely.

I recently saw an article about a couple who had shunned public education for their three sons and had educated them at home. (The article told that the youngest boy had been accepted at Harvard, where he would join his two brothers.) After reading *Scott, Foresman Life Science* 1987, I have a better idea of why that couple did what they did. ❖

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What Is Missing Is Science

by Hans O. Andersen

Scott, Foresman's book has roughly the same content that we find in other life-science books. We find the same content, too, in most of the standard and advanced biology texts used in high schools, and even in the freshman-biology texts used in colleges. At each successive level, the writers add more vocabulary, the books become heavier, the prices become higher, but the essential product stays the same. The books burden their readers with a plethora of jargon that obscures any science that may stray onto their pages.

One explanation for this is that many teachers have tried to use textbooks that emphasized problem-solving, but they have met with failure. Students did not want to think; they wanted to memorize, for they had learned that memorizing was the key to success in school. The teachers therefore inferred, wrongly, that students *were unable* to think. They returned to texts that emphasized facts and vocabulary, and they resumed teaching science as a foreign language.

It is not surprising, then, that Scott, Foresman's book emphasizes memorization, occasionally asks for some comprehension, but does not explicate the problem-solving nature of science. If the book were significantly different from any of the others, it probably could not be sold. A national curriculum has been established, in effect, by the textbook companies, through a process that can be easily understood. Assume for a moment that you want to produce a textbook. Your first question must be: What will textbook committees buy? A conservative, safe prediction is that they will buy a book very similar to the one that they already are using, so you now ask: What is the best-selling textbook today? Then you simply copy the best-seller, adding a few gimmicks that may make it more salable.

Each chapter in Scott, Foresman's book begins with an organizing paragraph, then a list of chapter objectives that tell what the student is expected to do after reading the chapter. The verbs used in stating the objectives tell much

about the book's pedagogic stance. Here is a table showing all the verbs, and the frequency with which each verb occurs, in the objectives of the odd-numbered chapters:

Chapter	1	3	5	7	9	11	13	15	17	19	21	23	total
explain		2	1	2	1	1			1	1		1	10
describe	1	2	2	1		1	2	2				1	12
list	1	1		1		2	1		2	1		1	10
compare								1					1
trace						1		1				1	3
identify					1				1		1		3
define	1										1		2
suggest				1							1		2
recite	1									1			2
contrast										1			1

Of 46 items, then, 32 call for explaining or describing or listing. The verbs *compare* and *contrast* — the only ones that remotely suggest performance requiring more than a minimal grasp of what the student has seen — each occur only once. Data like these may help to explain the observation that Willard Jacobson and Rodney Doran made when they wrote about "What Our Ninth-Graders Think" (in *The Science Teacher* for May 1986). "Many of our students," they said, "are just plain bored."

After its list of objectives, each chapter in the book offers a number of short sequences that obey a simple formula: questions-rhetoric-questions. A sequence opens with a list of questions that the student should be able to answer after reading the next passage of rhetoric; then comes the rhetoric, bearing the answers to the questions; then comes another list in which the opening questions are repeated in slightly altered form. For example: "Where do seeds and fruits come from" (page 136) becomes "What parts of a flower develop into a seed and a fruit?" (page 137). Most middle-school students will soon discern this pattern and will take to ignoring the first list or the second list or both, to avoid the sequence's obvious redundancy.

What is missing from the book is science. Science is an effort to formulate and answer questions, and a scientific endeavor often begins with a hypothesis — a question that can be answered by *yes* or *no*. Good hypotheses frequently arise from lesser ones, through the efforts of scientists who are practicing, among other things, the skill of asking questions. Students too must acquire that skill, and they must be encouraged to practice the formulating of questions that can be answered through research. A textbook should create opportunities for such practice, but in this book all the questions have already been chosen, cut and dried.

In typical cases, one or two question-rhetoric-question sequences are followed by an activity. Many of the activities are common in high-school courses and are indeed activities, rather than investigations involving the manipulating of variables. I can describe them by using the scale that Estelle Tafoya and her colleagues suggested in "Assessing the Inquiry Potential," in the January 1980 issue of *School Science and Mathematics*. Most are of the "confirmation" type: A concept is presented, and the student does an exercise that confirms it. A few activities involve "structured inquiry": A problem is presented to which the student does not know the answer, and the student then performs a prescribed routine and draws conclusions. None of the activities involves "guided inquiry" (in which a problem is stated but no routine for solving it is prescribed) or "open inquiry" (in which the student formulates the problem itself, as well as a way of attacking it). On the positive side, Scott, Foresman's activities are clearly written and generally demand only modest equipment. Students will find many of them enjoyable. Moreover, a creative teacher can upgrade some of them, at least to the level of guided inquiry. The teacher needs only to dissuade students from reading the activity before it is considered in class, so that the planning of the activity can become an exercise in guided inquiry, rather than mere confirmation or structured inquiry.

Each of Scott, Foresman's chapters ends with a summary, an "Interesting Reading" list, some questions, some "Extra Research" suggestions, and a test. Most of these, with the possible exception of some "Interesting Reading" items, are pedestrian and look like busy-work. After examining several of the chapter tests, I stopped trying to find anything intellectually challenging. Students can think, but they must be invited to do so. Scott, Foresman's program invites them simply to memorize. I cannot recommend it. ❖

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The Cloven Hoofprints of Creationism

by Michael T. Ghiselin

On page 6 of the teacher's edition of Scott Foresman's book, we find an odd note: " 'Bio' means 'life' and 'ology' means 'the study of' in Latin. You may wish to introduce students to Latin as the basis for life science terms. Explain that Latin was the language of educated people throughout Europe at the time of the Renaissance."

Teachers should ignore that note, especially because some students may be interested in languages. *Biology* does not come from Latin at all. It comes from Greek, as every dictionary tells. Are Scott, Foresman's writers really ignorant of this? Do they imagine that Greek and Latin are the same thing? Or are they simply "dumbing down" their book? This last seems to be a real possibility, given the way in which textbook-writers work nowadays.

In Scott, Foresman's book, that foolish note about Latin is right at home — not only because it is wrong, but also because it avoids facts that any competent writer would include in any attempt to "introduce students to Latin." The Latin language is no longer taught or used as widely as it once was, but its descendants are widespread and conspicuous. They include Italian, Rumanian, French, Spanish and all the dialects of each. They are diverse, but they all arose from a common ancestor. They all evolved.

Information like that would be out of place in Scott, Foresman's book because one of the book's goals is to keep evolution a secret. The writers' task, I infer, was to make something that could be sold as "life science" but would

ignore the evolutionary thinking that pervades legitimate life science in its every aspect. Their mission, it seems, was to make "science" conform to fundamentalist religion and the fundamentalist political movement called creationism.

If people want to proselytize, they should do it in a straightforward and honest way. I believe that if *Scott, Foresman Life Science* 1987 were adopted by a public-education agency, then defenders of civil liberties could argue credibly that the adoption violated the constitutional stricture against the establishment of religion by government. I shall focus on a few of the many points that might be used in building such a case, and I shall begin with a particularly flagrant feature that affects much of the book: the misleading depiction of biological classification.

Biologists use a classification system that is historical. They group organisms according to evidence of common ancestry, much as linguists group languages. (Remember Latin and its descendants?) The objective of biological classification is to reconstruct biological history and to delineate a genealogical tree, or pedigree, of life on Earth.

Scott, Foresman's writers, however, lead students to think that classification has no guiding objective and that it is done by arbitrarily picking some way of counting similarities. They open their chapter on classification with a misleading fantasy about dividing an assemblage of hats: "How would you do it? Would you sort the older hats from the more modern hats? Might you try grouping the hats that are similar in color, material, or shape? Would you separate the hats you like from the hats you dislike?"

This sets the student up for the misleading claim (on page 64) that the "one main process for classification" merely "groups organisms by their similar structure, behavior, food needs, and chemical make-up." The writers even mislead the teacher: On page T22, they suggest a "demonstration" involving the sorting of buttons. What a fine way to lead both teacher and students into thinking of classification without its historical context!

Can it be that the writers really think that taxonomy is a matter of capriciously picking any system that you like, as in the fantasy about hats? No, it cannot be, for they have betrayed themselves in a note to the teacher, on page 64: "In the past, many organisms have been misclassified. Some of the more notorious mistakes are the penguin, unicorn, rhinoceros, okapi, deep-sea crab ...." Never mind that these worthies think that the mythical unicorn is a real organism. Notice that word "misclassified." If classification were the arbitrary business that the writers present in their text, no organism could be "misclassified." With no fixed principles or goal, any classification would be as right as any other.

Having distributed hats and buttons, the writers now present an eight-chapter survey of various groups of organisms. They do this in proper eighteenth-century style, as if all living things form a single series culminating in an adult male human. Their text is misleading in many ways. Reptiles, for example, are treated in chapter 11 ("Cold-Blooded Vertebrates"), while birds and mammals are combined in chapter 12 ("Warm-Blooded Vertebrates"). This obscures the relationships among the three groups, and the effect is amplified by the omission of important information. The writers casually say that "most reptiles" have hearts showing incomplete separation into four chambers; students must infer that the exceptions are insignificant. In fact, the exceptions are the crocodilians, and their entirely partitioned hearts give signal evidence of their close evolutionary relationship to the birds.

For a superb example of the writers' corrupting science and logic, evidently for the sake of sectarian religion, look at page 89 and its account of the archaebacteria: "Some scientists think [that] these bacteria are just the type of organisms that might have survived the harsh conditions on earth. For this reason, they suggest naming the organisms *Archaebacteria*, which means 'first bacteria.'" That makes no sense. Archaebacteria exist now, so they clearly *have* survived — not "might have survived" — the conditions on Earth. And more than "some" scientists grasp this. The passage makes no sense because something is missing; something has been left out; something like "3 1/2 billion years ago, when the first organisms were evolving."

The writers finally acknowledge evolution in chapter 21, fatuously titled "Change Over the Years." Their material is incompetent and severely misleading. One of the most curious passages comes when they acknowledge that evolution involves not only "change" but common ancestry. We read: "Body parts of different species that have similar structures which developed in similar ways even though they do different work are called homologous .... Many scientists think that organisms having homologous body parts might have inherited these traits from common ancestors."

That is false. In modern comparative anatomy, homologous parts are *by definition* those that have a common ancestry. This is a canon of biology, not just something that "many scientists think."

Some of Scott, Foresman's passages defy analysis because we cannot discern whether they signify creationism or a less formal brand of ignorance. The passage about homology is one of these. Another is the glossary's definition of *species*: "a group of related animals or plants that have permanent characteristics in common." Nonsense. A species has no permanent characteristics. In principle, it can evolve indefinitely and can diversify into descendant groups that may even include new genera, new families, and so forth. To deny that a species can evolve is like denying that a language can diversify into new forms. Scott, Foresman's definition may be just a clumsy mistake, but it looks like another cloven hoofprint of creationism. ❖

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CANDID APPRAISALS OF SCIENCE TEXTBOOKS

IN THIS ISSUE:

Heath Earth Science teacher's edition ISBN 0-673-22341-8
D. C. Heath and Company, 125 Spring Street, Lexington, Massachusetts 02173

The Good, The Bad, and The Unacceptable

Heath's *Earth Science* is the first non-biological textbook that has been the focus of this journal, and it has been given mixed reviews by the two scientists and one science educator who examined it. Reviewers identified good or bad parts of the text, but all pointed to unacceptable errors of fact and to alarming omissions of content. Two of the major problems cited were the absence of a discussion of evolution as it relates to earth science, and the lack of descriptions showing science as an active process.

While this is an "earth" science text, the reviewers felt that to be a contemporary teaching tool, a book must include more than information about rocks and minerals. It must incorporate those major concepts from other disciplines which demonstrate the complementarity of processes that have shaped the world as we know it. The mention of fossils found in successive subterranean layers without fully explaining their relationship to biological evolution presents a static and narrow image of dynamic forces and changes on Earth.

While this is an earth "science" text, reviewers noted that science is not portrayed as an ongoing process which results in the development of new ideas and changes in old ones. The text is laden with facts about earth science, but it lacks the relationship between these facts and the methodology of science that produced them. Scientists build on knowledge that has been obtained by others, and learners learn new information building on what they already know. However, one reviewer felt that the text did not explain how scientists obtain knowledge, nor did it aid learners by linking facts to concepts.

The reviewers have reached different conclusions about the overall quality of the same text. Does this mean that the reviews are contradictory? Not in the least. The reviewers noted similar problems, but came to different conclusions based on their personal knowledge and observations of the text material. Textbook choosers need to make intelligent decisions for themselves based on accurate information. The reviewers of Heath's *Earth Science* have, while evaluating the text, provided this basic information. This is one of the goals of *Bookwatch Reviews*.

Gordon Uno, Editor
William V. May, Editor-in-Chief

Honesty Without Fear

by Christopher Palmer

This review of *Earth Science* is presented with the following guiding questions — are basic geologic concepts given to the students to help them understand their world, to help them understand science, and to help them deal with urban environmental problems? The dismal lack of understanding of scientific concepts and facts results in an uninformed public, which is disastrous for the discussion and solution of public issues. A good text can help to produce informed citizens who are able to deal with such concerns.

Overall, I found *Earth Science* to be contemporary and to contain most current trends in geology, however, the text does contain numerous mistakes. For instance, there is a glaring error in the "Science Background" materials for teachers that give inaccurate numbers for both thickness of sediments and length of time sediments have been deposited at the gulf of the Mississippi. Also, the book holds back — students should be challenged with more concepts rather than endless sequences of facts. The glossary seems complete, but oversimplistic. For example, geologic eras are not time-defined, and fossils are not defined as evidence of past life.

Text discussions of the universe, solar system and the Earth are complete in a descriptive sense (e.g. number of planets), however, the Big Bang Theory and star-forming processes should be presented in much greater detail, with more updated information from recent deep-space probes. The chapters on weather, climate, fresh water and oceanography are interesting, with examples of weather processes, observation, and measurement emphasized. These chapters are a good introduction to the more pure earth science part of the text that follows.

The text dealing with minerals and rocks is very good, presenting crystallographic systems, atomic structure and physical identification of minerals. Encouraging students to start rock and mineral collections is great — it started me on a career in geology! This section is current in terms of crustal and planet core structure with good notes for teaching examples. Plate tectonics are discussed but the relationship of earthquakes to rifting and other geological processes should be more forcefully presented. In my opinion, the Theory of Plate Tectonics is the greatest advance in earth science this century, and it should be

completely discussed. The New Madrid earthquake of 1812 is cited under the section that questions the plate tectonic model. Recent USGS data indicate that this may be a failed rift center, which supports plate tectonics. While some aspects of the theory are debated, it is universally accepted by geologists, and this agreement should be emphasized.

The Rock Record and Geologic Time discussions are uneven and, while factually correct, unenlightening and oversimplified. Index fossils are discussed, but the worldwide occurrence and rapid extinction which make them index fossils are not mentioned. The sandstone-shale-limestone deposition model is out-of-date, derived from regional stratigraphic formation mapping and correlation done decades ago. Limestones don't occur in "deep" oceanic environments but are shelf deposits. Turbidite currents may deposit limestone breccia at depth, but marine limestones are shallow water deposits. Many other depositional models exist and could be presented. If the text goes to the trouble of presenting basic stratigraphic ideas, then it should use current models and examples. The text states that geologists "believe" sedimentary rock layers were deposited in horizontal layers — well, this is a fact, and it must be stated as such.

The fossil section is presented in vague and slanted discussions. Demonstrations and diagrams briefly mention fossils as once-living organisms, and that fossils are used for correlation of strata and relative dating. Radiometric dating is emphasized, which is okay, but historical geologic discussions are non-existent. These chapters are the low point of the text. Most unfortunately, biological evolution, as related to geological time, is not discussed once in the text, and only once in the teacher materials. Invertebrates and their use in "dating" stratigraphic sequences are used daily by oil companies to find and collect oil. This relative dating is as important as radiometric dating — perhaps more so because all rocks can't be radio-dated. Various causes for extinction of animals are presented to the teacher only, not to the students, and these include the questionable hypothesis that "mammals ate dinosaur eggs, so dinosaurs died out." The biggest problem is that the evolution of life from invertebrates to vertebrates is not mentioned, nor are other evolutionary events such as the evolution of major groups of plants. Stratigraphy and paleontology should be discussed together because they are complementary.

The final chapters on the resources of the Earth and its environment are well done. In these, earth science is applied to the daily life of the student. The energy and resource chapters are informative and balanced in discussing energy source extraction and use. A "choices" approach for pollution and resource use is very good because it encourages student thought about pollution problems which they will face. Often, a public that is ignorant of science is not equipped to deal with problems such as hazardous waste disposal or the sudden loss of clean drinking water, problems that demand public review of innovative scientific solutions. The authors have made a good effort to show science as it applies to the life of the average citizen.

My overall impression of this book is a positive one. I think the text conveys most of the geological facts clearly, although they should be related in a better way to the major geological concepts. The presentation of material is made lively so students will stay interested, and I feel this book presents good discussions given the intended audience age does not exceed 13 or 14 years.

Text errors and misstatements are unforgivable, however, and much correction must be done prior to teaching with this book. The most important function of a text, especially a science text, is to educate truthfully and completely. Knowledge needed to understand and solve geological and environmental problems must be current, correct, and revised endlessly, and I think that while the book labors, it gets its message across. It is, however, unfortunate that major concepts such as evolution are missing. The motto of William Thompson, a famous Scottish professor later known as Kelvin, seems most appropriate here: "Honesty without fear." It would be nice to have textbooks tell the truth without worrying if the information is "inflammatory."

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Missing — Links

by Richard Duschl

There are no procedures in science more important than those that generate and evaluate new knowledge. Judged by the first chapter, the author of *Earth Science* would seem to agree. But, the text oversimplifies the complexity of the processes it chooses to discuss. Consequently, there is a misrepresentation of the character of evidence and the processes of science employed in knowledge generation and evaluation in the earth sciences.

As stated in the text, "Solving a puzzle is like using the scientific process. You study the pieces, analyze how they may fit together, and try possible arrangements until the puzzle is done." But a piece of the puzzle is missing for Heath. Observations are not devoid of theoretical influence. All observations are determined by a set of standards based on what is already known. This same position is also held for learners, namely, all learning is based on existing knowledge. Thus, I am disappointed with the presentation of the scientific process found in Chapter 1. It is so simplistic that it is in reality a very empty presentation and a shallow consideration of scientific inquiry. Today, more than in the past, students need to be introduced to the nature of scientific evidence. It is incorrect to assume students openly accept the knowledge of science at face value. Proposals that continents move, that crystals are made of atoms, that glaciers miles thick covered much of the Earth, and that the Earth is 4.5 billion years old are powerful claims to make to children. What is the evidence for these statements? What is the argument pattern employed that compels us to believe that each of these claims is indeed true? To merely state that it is true or to present the textbook as an ultimate source of authority in science is to miss developing a very important element of science education. That element is the need to develop in children the ability to

assess the degree of legitimate doubt in the knowledge claims made in science.

In many states, the earth science course represents one of the last two courses students will ever take in science. This fact places an added burden of responsibility for the course to be something other than a course for future earth scientists. A theme for the entire book should be an accurate and relevant depiction of science inquiry. Let's not pretend that science is always correct. Yes, science is self-correcting, but this can take time and effort. By presenting science with an authoritative perspective, we are doing a disservice to learners. Establishing among learners that change in scientific knowledge is a natural and, in the long term, a rational process is the more difficult challenge we face as science teachers. Thus, learning how to think like an earth scientist should take a back seat to understanding how the larger community of scientists goes about its collective enterprise of seeking explanations about various aspects of the Earth.

Earth Science asserts that thinking like an earth scientist involves observing. Much information contained in the text is derived from observational techniques quite remote from the use of our senses (e.g., magnetic reversals on the ocean floor, and age of rocks using radiometric dating methods). But how do we observe these phenomena? The inclusion of a paragraph on how instruments can be used to extend our senses just doesn't cut it, because in the study of magnetic reversals or ages of rocks it is not until the data are spewed out by a computer that the human senses are used.

It is difficult to criticize the choice of what has been included in the textbook — it represents mainstream thinking about the general knowledge associated with the amalgamation of disciplines that come under the heading of the "earth sciences." However, *Earth Science* does not fulfill its claim to "explain concepts fully" and to "show(ing) links between ideas." In order to fulfill these claims, a perspective of learning is required that considers much more than merely grouping facts, laws, principles, and theories into sections, chapters and parts. In Unit One — The Universe — the sequence of instruction begins with concepts about Outer Space and moves closer to the Earth. Such a sequence begs the question of why anyone would presume that this format would facilitate meaningful learning. The logic of the sequence may be useful for scientists trained and familiar with the concepts, but let's not forget that the users here are supposed to be learners — novices. Research on learning in science has found that it is best to begin with what the learner knows and to build from there. In many instances it has been found that the best sequence for teaching theoretical content, and there is no more theoretical domain in science today than astronomy and astrophysics, is the historical sequence of the growth of knowledge.

The story of the development of the Heliocentric Theory of the solar system is a marvelous example of the growth of scientific knowledge. Examining the evidence and arguments that contributed to the demise of the geocentric view, and the new and more accurate predictions of planetary motions by the heliocentric view represents a wonderful case study of how scientific knowledge changes. In *Earth Science* we find Galileo's discovery of the moons of Jupiter and of the surface of the moon disconnected from knowledge growth of the Heliocentric Theory. Instead, these important pieces of evidence for establishing credibility to Copernicus' view are used as a two sentence lead-in to telescopes. Where is the link between major ideas here?

Although most of the information contained in *Earth Science* is accurate, there are numerous cases where little consideration has been given to the sequence and organization of the material. The result is that chapters treat information in isolation or as disconnected facts and that major concepts are buckshot across different units. Consider that the Theory of Plate Tectonics appears in Chapter 15 — Unit 4 — and that presentations of the Rock Record, Geologic Time, and the Fossil Record appear, respectively, in Chapters 19, 20 and 21 — all Unit 5. Now, any earth science teacher worth his or her salt will truly recognize the fact that the meaningful teaching of plate tectonics requires basic conceptual understanding of these concepts. The present sequencing misrepresents the importance of the prior knowledge needed to appreciate the evidence in Chapter 15, and it misrepresents the procedures employed in the development of the Theory of Plate Tectonics. Unfortunately for students, this isn't an accurate representation of the procedures for acquiring scientific understanding. Understanding in science involves knowing relationships among concepts as well as the procedures used to choose and evaluate evidence.

Earth Science has a long way to go before it begins to provide a resource to teachers which facilitates students' needs. As advertised, *Earth Science* sought the input of teachers and has met the needs of teachers. In subsequent editions I hope they will address the needs of learners. A new conception of learning in science has evolved, and it is time that the basic tenets of cognitive structures and conceptual change approach be incorporated into the curriculum. There is little evidence to suggest the author or editors have considered contemporary ideas about children's learning in science and about teachers' cognitive decision-making. Inasmuch as textbooks often become the curriculum for many school districts, publishers should consider these ideas more seriously.

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I Don't Believe It

by Arthur J. Boucot

Heath's *Earth Science* is another specimen of a dismal genre: the commercial textbook that is being sold for use in earth-science or life-science courses in our public schools. I studied the teacher's edition, and the effort left me drained. Books like this show us why intelligent students are turned off, average students are confused, poor students are bewildered, and teachers become burned out.

The designers of *Earth Science* have used all the currently popular techniques for making a minimum of content occupy a maximum number of pages. On typical pages, 30–40% of the available space is blank. The text is set in excessively large type and includes illustrations that often are irrelevant, carry uninformative captions, or,

for those at the beginning of units, carry no captions at all. The quality of the illustrations generally is poor, the images commonly blurred as to make critical details indistinct. Moreover, the merciless use of colored pictures produces an overdose. To me, all that color seems more distracting than useful.

The teacher material states: "A team of highly trained experts — specialists in various fields of earth science — have checked and double-checked every page of Heath's student text." Personally, I don't believe it, for I had no trouble finding blatant errors of fact and major problems with the presentation of material. For example, early in the text, there is a masterpiece of confusion about stratigraphy. While trying to convey that the oldest parts of a stratified deposit are at the bottom, the text shows a complex, totally unrealistic diagram of a rubbish pile. The diagram is labeled, "A 10,000 year old dump," but every "waste pocket" in the dump contains objects that obviously are modern. (One of the deepest items in the deepest pocket is a clock-face showing Arabic numerals!) This would only make sense if the students were told that this is a dump of a city many years in the future. However, the way it is presented certainly could be confusing to children, and it is misleading.

A note to the teacher states: "Prior to 1912, minerals were analyzed by the powder and solution method." If the 19th-century users of the petrographic microscope could read that blather, they would turn over in their graves. Later, we find in the student's text: "The earth's crust is made from about 92 different building blocks." I assume that this refers to the 92 naturally-occurring elements, but I wonder why the word "about" is used. Is the author unsure about how many elements there are? Certainly, students may wonder about this indefiniteness. And, is it assumed that the use of "building blocks" rather than "elements" promotes education and makes it easier for the science teacher to explain concepts more effectively?

The text states that: "There are about seven major properties that are useful in identifying minerals. They are color, streak, luster, hardness, cleavage, fracture, and density." The impression conveyed — that these are the major properties used in identification — is false. These really are mere ancillaries. They may be interesting historically, but they lack the practical importance of various other properties such as those disclosed by X-ray techniques. On the very next page we see: "The color of a mineral is obvious, but it is not very useful for identification." That statement is true, but will anyone who has read the text believe it? There is no attempt to reconcile this with the earlier declaration that color is one of the major properties useful in identifying minerals.

The treatment of paleontology is confined almost entirely to one chapter, 18 pages long, that is flawed and false. An especially prominent flaw is the diagram spanning two pages that shows whales and squirrels living in the Cretaceous, some 70 million years before their first appearance in the fossil record, and it has butterflies and dragonflies living in the Mississippian, about 100 million years too early. A major sin of omission is that the word "evolution" never appears in the text. It is never made clear that the fossil record — as a history of life on Earth, or as an indicator of relative geologic times — is a record of continual succession. And it is never even hinted that this succession has been explained by the principle of biological evolution, or that biological evolution is one of the great themes of paleontology. As a result, much of the chapter is meaningless, and all of it is misleading. Is this the product of a prodigious oversight, or is it a sop to the creationists?

I have cited some problems already, but a few more examples are in order. On the first page of the student's text, three paragraphs invoke glaciers in an attempt to suggest something about the work of geologists. "Consider the example of glaciers," the text says. "Many different kinds of observations are made at glaciers." However, not until over 300 pages later does the student learn what "glacier" means. Comparable treatment is given to "fossil" which appears for the first time in a meaningless paragraph on page 6 but which is not defined until page 296. Potentially confusing is the attempt to explain the concept of density by invoking equal volumes of iron and of cotton. Might it occur to the student, however, that a wad of cotton contains a lot of air spaces, while a piece of iron does not? Problems also exist in the references to teachers. A note to the teacher suggests citing zircon and rutile as examples of tetragonal crystals. These two minerals are mentioned nowhere else in the book, however, and the teacher will have to look elsewhere if any student asks what they are.

The book offers many pictures of rock exposures, rock specimens, mineral specimens or fossils, but it rarely tells where these things occur, how old they are, or what their significance is. There are many missed opportunities to teach something about geography, history, biology, or the other subjects to which earth science is related. And, there are many lost opportunities to make earth science itself more meaningful to the student.

I could go on, but I think I have told enough to show what is being foisted upon long-suffering students and teachers, and onto the taxpayers who foot the bill for textbooks. Is there a remedy? What should be done to secure the production of competent textbooks, instead of these caricatures of science education? Might it help if publishing companies were to insist that people demonstrate some professional competence before being hired to write science books? Is that too much to ask? Please do not buy this book for your school. And if you live in a state that has a textbook commission and makes state-wide adoptions, please ask the commission to reject this product.

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CANDID APPRAISALS OF SCIENCE TEXTBOOKS

IN THIS ISSUE:

Prentice-Hall Life Science teacher's edition ISBN = 0-13-536137-0
Prentice-Hall, Inc., Inglewood Cliffs, New Jersey 07632 **Middle School/Junior High Level**

Passing the Test? A picture may be worth 10,000 words, and Prentice-Hall *Life Science* has many pictures. *Life Science* certainly passes the "thumb test" — that is, the text is appealing to the eye as one flips through the pages. It is filled with colorful photographs and illustrations and the layout looks good. However, the "thumb test" is an inadequate measure of a text's intellectual contribution to the classroom. One must question whether all illustrations are necessary and, if they do serve a function, would black and white carry the information as well as expensive color? The escalating cost of textbooks is primarily due to a book's design. Color illustrations and lavish white spaces are appealing to the eye but they necessitate the shortening of the textual material. Our reviewers agreed that much information is presented in *Life Science*, however, they felt that too many topics were attempted without enough explanation of that which was included. The text is over 600 pages which are divided into seven units, over 100 sections, and many more subsections and topics. With fewer illustrations, explanations could be expanded and might be improved. Our reviewers also commented that the authors could increase the amount of "science" in their text with less emphasis on the facts and vocabulary and more emphasis on experimentation. Laboratory investigations *are* incorporated into the book so students can look forward to the opportunity to try these exercises. However, the labs could provide more real opportunity to hypothesize and to see how scientific data are produced. The reviewers felt that directions and comments addressed to the teachers were simplistic without providing enough thoughtful and useful guidelines for discussions with realistic student responses that could be used to promote learning. What might be considered in future editions is more information on how teachers can lead active, inquiry-oriented, open-ended exchanges with students. It is hoped that Prentice-Hall *Life Science* teachers will incorporate suggestions for improvement from the three reviews, and correct errors noted by the reviewers. And, we believe that publishers and authors can profit by using the reviews to improve their future products or to create new works.

Gordon E. Uno, Editor
William V. Mayer, Editor-in-Chief

Thinking Holistically

by Linda Wolfe

Since 1972, and at several universities, I have taught an introductory course in biological anthropology which covers evolutionary theory, primate and human evolution, primate behavior, and human variation. Over the years I have become concerned about students' lack of basic biological knowledge and about their inability to think holistically. I expect that a college student should have some understanding of human biology, Mendelian genetics and gamete formation, the interrelationship of plant, animal and human evolution, and how humans affect the ecological systems of the Earth. All citizens need a sound knowledge of biology and ecology in order to make their best personal judgments (e.g., "Which contraceptive is right for me?") and their most informed public decisions (e.g., "For whom shall I vote?"). In general, students I encounter have little grasp of themselves as part of the natural history of the Earth or as being connected to other organisms in the world. Unfortunately, Prentice-Hall's *Life Science* perpetuates a lack of understanding of biological, ecological and evolutionary processes because it does not provide an adequate and integrated view of the life sciences.

The content of this textbook is often a hodge podge of information that is disconnected, misleading, or inadequate. For example, cold-blooded vertebrates are discussed in Chapter 10. A couple of pages are devoted to the reproduction of amphibians and reptiles. Students are asked, "How do reptile eggs differ from amphibian eggs?" However, there is no discussion of the evolutionary connection between reptiles and amphibians or about the adaptive significance of the "reptilian revolution" which freed animals from needing a pool of water in which to reproduce. Furthermore, the changes in the environment and landforms during the Paleozoic Era which led to the evolution of reptiles from amphibians are ignored. The concepts of evolution, adaptation, ecology, and conservation are presented in Chapters 22-25. This placement isolates these subjects in the back of the textbook where they can be ignored. The discussion of these concepts is very general, and it is difficult to relate

the information in these later chapters to the discussion in earlier ones. The authors could have produced a more integrated textbook had they begun with a clear statement on evolution and adaptation and used these concepts throughout the book.

In Chapter 11 students are told that the apes "...are the closest mammals, in structure, to human beings." This statement is misleading because it obscures the evolutionary relationship between the apes and humans. Humans are the mammals closest to the apes not just "in structure" (i.e., anatomy), but also in reproduction, physiology, karyotypes, immunology, DNA, and behavior. (Chimpanzees *do* make tools, contrary to the text.) Had the authors wanted to demonstrate the relatedness of humans and other primates, they could have discussed the work of Dr. Allan Wilson and colleagues showing similarities in the DNA of the great apes and humans. The authors do discuss Wilson's work on the DNA of zebras and their relatives. It is not, therefore, unreasonable to assume that the authors knew of his work on humans and their primate relatives but chose not to include it.

This same inadequate and misleading discussion of evolutionary relatedness pervades the discussion of taxonomy in Chapter 4. The students are correctly told that all plants and animals are named and classified according to similarities in structure. The students are not told, however, that scientists place organisms into taxa because the similarities of the organisms reflect and communicate evolutionary relationships. The whole question of relatedness is ignored in the discussion of taxonomy — whose very purpose it is to form the language with which scientists communicate about such relationships.

I found the discussion of sickle-cell anemia particularly distressing. The students are told, "A person who has sickle-cell anemia inherits a damaged gene for the manufacture of hemoglobin..." This is not, of course, an accurate statement. The gene which is involved in the production of sickle-cell hemoglobin is slightly different from the gene which manufactures non-sickling hemoglobin, but it is not "damaged." Moreover, evidence indicates that the sickle-cell trait is an adaptation to the disease malaria. It is mystifying to me that in the Teacher's Guide the relationship between malaria and the sickle-cell trait is pointed out, and at the same time students are told that the gene for sickle-cell hemoglobin is "damaged." It would be better for the students to have been given the whole explanation, connecting the razing of rainforests for agricultural purposes, the proliferation of mosquitoes in stagnant pools, the occurrence of malaria, and the genetic response (i.e., sickle-cell hemoglobin) rather than the dubious "damaged" gene story. In the South where I currently teach, many of the students have seen propaganda from white supremacist groups which tells readers that sickle-cell hemoglobin is only found among people of African descent (which is not true) and that it is a genetic disease caused by their immoral behavior (which is a blatantly false statement). My fear is that the "damaged" gene treatment of sickle-cell hemoglobin in Prentice-Hall *Life Science* will, in some students' minds, reinforce the message of the propaganda, no matter how innocent the intent of the textbook's information.

I object to the style in which college-educated life science teachers are addressed in the Teacher's Guide. For example, consider the following quotes from the teacher's materials:

1. Have students focus in on the "knobbed" part at the top of the fin. Point out that this fish was caught in the Chalumna River in South America. Write "Chalumna" on the chalkboard.

2. What are the stages in the metamorphosis of a frog? (Tadpoles hatch from eggs laid in water. The tadpoles gradually develop into the adult frog.)

3. Have students rub their hands up and down their arm. What do you feel? (Accept all logical answers. Lead students to realize they can feel the hair on their arms.)

My question is, "Do life science teachers need to be told exactly what to write on a chalkboard, be given information that tadpoles develop into adult frogs, or be provided with a gimmick to tell students that they have hair on their arms?" If I took that Teacher's Guide seriously, I have to conclude either that: a) the people who teach life science courses know nothing about biology; or b) the people who wrote Prentice-Hall *Life Science* believe that life science teachers are poorly prepared to teach the subject. Either way, the professionalism of life science teachers is called into question.

Linda Wolfe is a faculty member in the Department of Anthropology at the University of Florida in Gainesville.

So Many Topics, So Little Time

by David Stronck

Life Science from Prentice-Hall is designed to provide a program on "the topics most widely covered by life science courses" in the junior-high or middle schools. The reading level is appropriate for these students. The book has a remarkable range of topics from the most introductory to those presented in senior-high school. A reader may fear that each of the many topics cannot be sufficiently addressed to provide an understanding of the scientific concepts to junior-high school students. Nevertheless, the text asserts that it will feature, "The difference between memorizing facts and understanding science." Science educators will be delighted with this worthy goal and will examine the book to verify its intended emphasis on "understanding" and avoidance of "memorizing." I discovered the following: 1) the introductory chapter emphasizes understanding of basic skills and the nature of science, and 2) the other chapters tend to emphasize the memorization of vocabulary. For example, Chapter Two has 25 new terms; three pages in this chapter "cover" such terms as "atom, electron and element." This section is essentially a list of definitions

without any reference to how scientists "discovered" such concepts. In another similar section, DNA and RNA are covered in only 140 words on one page. In general, the book attempts too many topics without adequate explanations to allow for understanding. If a teacher sinks into the common practice of merely stressing vocabulary, they will find this text a relatively easy book to use. Almost every page has several new terms provided in bold print with ronunciation assistance and definitions; most chapters provide 20-45 new terms. There is also a large glossary at the end of the text.

Perhaps because this textbook attempts to cover so many topics, it has many problems related to clarity and omission. Only two pages deal with "Genetic Engineering: Promise or Peril?" These pages are mostly a one-sided assault on the most productive of the emerging aspects of modern life science! They do not recognize what is happening in terms of governmental regulations, safety and containment standards in the laboratory, or the financial commitments of industry to this technology. Many chapters contain brief statements about career opportunities, but there is no mention of employment in the huge and rapidly-expanding biotechnology industries.

The feature on genetic engineering is part of the text's series on "Issues in Science" which is designed to promote debate among the students. Another issue is "Animal Experimentation: Is It Necessary?" Teachers are encouraged to organize debates on banning the use of animals for research before students are given any informed insights into the problem — the text lacks information which students can use to make judgments. Obviously, a debate involves presenting a positive argument and a negative argument on a single resolve. In these cases, however, arguments are difficult to make without extensive research outside of the text. On still another issue, teachers are encouraged to "have students choose a basic criterion to govern decisions for saving endangered species." This group activity does not suggest how the students should be organized to reach the stated goal, and certainly there is no defined resolve or premise here for a debate!

The Teacher's Resource Book contains tests for each chapter. The test for Chapter One has many good items, e.g., those requiring the interpretation of a graph. For most of the other chapters, however, test items seek almost exclusively the recall of memorized terms, not interpretation. Each of the 25 chapters of the text has from one to several laboratory investigations or activities; 59 in total. It is suggested that "the students be asked to provide hypotheses to each problem presented in the Laboratory Investigation." However, most laboratories do not pose problems that suggest any hypothesis. For example, Investigation 5 has the problem: "What are the parts of a microscope?" Investigation 11 asks: "What are the stages of mitosis?" Moreover, most of the lab activities stress observations and vocabulary that can be learned essentially by studying the diagrams and reading the textbook. A teacher can omit doing the investigations listed in the lab manual because they are supplemental to the content of the textbook, not an integral part of developing scientific concepts.

The textbook is filled with numerous attractive photographs and diagrams. The captions on some of the photographs are excellent because they require interpretation or observation, e.g., "Can you see the young deer in this photo?" Other captions seek only recall of memorized terms with no real reference to the photo, e.g., "Why is the rock that the lizard rests on not considered part of the community?"

The sequence in the presentation of evolution presents a complicated and confusing jumble. The term "evolution" is not mentioned until Chapter 22 with only three more chapters in the book. This location may encourage some teachers to omit "covering this topic" when there are so many other chapters earlier on. An historical and logical organization of evolution would be: fossils, Lamarck, Darwin, and the DNA clock, not this book's sequence of Lamarck, fossils, DNA clock, and Darwin. This organization tends to destroy conceptual development and to leave the reader struggling with a disjointed list of new vocabulary terms to be memorized. There is no attempt to distinguish between the basic concept of evolution as "change in a species over time" and the mechanisms explaining how this evolution may have happened. Prentice-Hall *Life Science* misses opportunities that could help students organize their concepts related to evolution. For example, the work of Stanley Miller in 1952 is mentioned, but not related to the first primitive forms of life. Neither is an interesting discussion of the coelacanth related to the short discussion of fossils.

There are many small points in this textbook that need correcting. For example, the textbook describes the slime mold as having two stages when it actually has three. The text states that "The gorilla is the largest primate. It may grow to a height of 1.8 meters." Based on this measurement, humans are larger. The Pacific Coast Coniferous rain forest is classified as "deciduous forest." On the same page, the color codes for desert and grasslands appear to be the same. "Homeostasis" seems to have two different definitions on two different pages. The description of the Carbon-14 method of radioactive dating is incomplete. An explanation is needed that living organisms are constantly incorporating into their tissue new C-14 that was recently created by the bombardment of N-14 in the atmosphere, and that C-14 is always decaying.

The text lists the four major food groups without any discussion of recommendations for diet or of major dietary problems. The implication that people will have a healthy diet by including something from each of the four food groups at every meal is simply incorrect. This text includes such trivia as the names of ten digestive enzymes with their substrates and products. Junior high-school students need a relevant discussion of diet and food, not the memorization of meaningless words.

In the chapter on reproduction and development, although the term "penis" is used, it does not appear in the diagram of the male reproductive system. The term "sexual intercourse" is omitted and "sexual contact" is not defined. This confuses the discussion of AIDS in the following chapter. The AIDS epidemic has taken away the luxury of speaking in ambiguous euphemisms. We must tell students clearly that AIDS is transmitted by blood, sperm, and vaginal fluids, and not by saliva, tears, sweat, or other bodily fluids. Moreover, the text omits any mention of the transmission of AIDS by hypodermic needles shared among drug-addicts who are infected with AIDS. Unfortunately, this is now the second most common way of spreading the AIDS virus in the U.S.A. The basic problem with Prentice-Hall *Life Science* is the excessive emphasis on vocabulary without clear and sufficiently complete explanations. Junior-high school textbooks should deal with fewer topics, and these topics should motivate the students. A good textbook should provide full explanations that lead to conceptual frameworks and should be far more than a dictionary of scientific terms.

David Stronck is a faculty member in the Department of Teacher Education at California State University, Hayward.

Traditional Life Science

by William Frase

Prentice-Hall's *Life Science* represents all that has been typical in traditional middle school/junior high school life science since 1970. If multiple authors and pretty pictures sell textbooks, Prentice-Hall has a salable product. If, however, teachers and curriculum committees are looking beyond the pretty, fact-filled but shallow, and cookbook science sources, *Life Science* falls short.

The copy of *Life Science* reviewed was an annotated teacher's edition which included chapter overviews, motivational strategies, suggested teacher demonstrations, content development, skills development, underlined text materials, and performance objectives. The inclusion of these aids should be commended. Unfortunately, most of these materials are either geared toward the beginning teacher with a degree in a field other than science and/or a teacher who is extremely unprepared. It is humorous, or perhaps disturbing, to note questions for teachers to ask their students, such as, "What did you observe?, What did you conclude?, What type of foot walks best on sand?, Why is the heart important to the body?, or What else on your body is the size of your fist?" A far too common answer to these questions is, "Accept all logical answers." One of the more amusing activities listed under "Teacher Demonstrations" and part of the chapter entitled "Classification of Living Things" is an activity in which the teacher collects "a very large box of assorted objects" which is followed by:

Show the box of "junk" to the students. Say "I'd like you to find me a 2-cm screw. What's the matter? Don't you think you could find a 2-cm screw in this box?" (Accept all answers but most students will say no.) "Why not?" (There is too much stuff.)

This is the norm, not the exception. I'll let you decide if such an activity has relevance to classifying living things and whether looking in a box of "junk" will lead to higher scientific pursuit.

My guess is that the authors, when first formulating this text, sat down and chose all the important topics in general biology including taxonomy, anatomy and physiology, ecology, and genetics. They then tried to cover as many of these topics as possible. The result is that the majority of these content areas has very little information. I was appalled to find photosynthesis reduced to five paragraphs, the male reproductive system reduced to two paragraphs, and the whole discussion of the entire plant kingdom reduced to 27 pages (the discussion of gymnosperms was limited to five paragraphs; angiosperms only rated three). As is typical of most life science texts, authors feel the need to describe all of life and its interactions; but they soon find the topic so large and convoluted that in an effort to reduce information to a manageable size, they end up with a patchwork quilt of incomplete, disjointed information with little connection between parts. It is better to not mention metabolism or cellular respiration at all than to give them three short paragraphs each.

I understand the tremendous task that the authors had in assembling this life science text, and I understand the problems of conducting such an activity, and I wish I could defend the ultimate product. One of the major downfalls of this text is that "science" is missing from the book. Science is the formulating and answering of questions. In the section entitled, "What is Science?," the classic explanation that science "comes from the Latin word 'scire,' which means to know" should be the approach of this text. Instead, this book is a compendium of facts with little emphasis on process, even though many activities are designed to accomplish this end. There is very little emphasis on comparisons, contrasting or explaining, and open inquiry is nonexistent. There is no knowing.

William Frase is an Associate Professor of Biochemistry at the University of Cincinnati and is the President of the Society for College Science Teachers.

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CANDID APPRAISALS OF SCIENCE TEXTBOOKS

IN THIS ISSUE:

Holt Modern Biology, 1989 teacher's edition ISBN = 0-03-013922-8
Holt, Rinehart and Winston, Inc., 1627 Woodland Avenue, Austin, Texas 78741 **High School**

The Evolution of *Modern Biology* Evolution happens. Some argue that it occurs slowly over a long period of time; others hold that evolution takes place rapidly. In the case of *Modern Biology*, parts of it have changed dramatically in the past few years, while other parts in this encyclopedic book have evolved little over its long history. Two of our reviewers agreed that, except for noted errors, the content of the text is impressive and that the author makes a courageous stand with the inclusion of evolution in its rightful place as a central theme of biology. The science educator, however, observed that, while the content is indeed impressive, the pedagogy is not — the text's objectives call mostly for recollection of facts and not much evaluation or prediction. Our reviewers noted that the text fails to distinguish between a theory and a hypothesis, slighting the wide acceptance of theories and their importance as the framework on which biological principles are laid. On the whole, however, two of the three reviews are quite favorable. *Modern Biology* is and has been the most widely used biology text ever produced. We applaud the inclusion of evolution as a theory central to biology in this edition and hope that other publishers will encourage their authors to participate in the type of "directed evolution" seen in this text. While not enough changes have been made to satisfy all three of our reviewers, *Modern Biology* 1989 does show that evolution in the textbook industry can occur, albeit, in most cases, slowly.

While *Bookwatch Reviews* is the only journal exclusively devoted to reviews of science textbooks, other journals also provide insightful, periodic, analytical reviews of textbooks. *The Quarterly Review of Biology*, for example, reviews science texts from time to time, and *Science Books and Films* produces special issues devoted to high school science textbook evaluations. Upcoming in this excellent series is the March/April 1989 issue, wherein nineteen biology, chemistry, and physics texts of recent date will be subject to in-depth reviews. This March/April issue will update past review efforts. For further information about this upcoming issue, write Kit Johnston, Editor, *Science Books and Films*, AAAS, 1333 H Street NW, Washington, DC 20005.

Gordon E. Uno, Editor
William V. Mayer, Editor-in-Chief

A Valiant Effort

by Niles Eldredge

As my kids have wended their way along the educational path to high school, I have always checked their texts to see how the world's important concepts, as well as its basic data, are being presented to them. I paid particular attention to their science texts — and not *just* because creationism and other forms of weasel-worded pseudo-science have increasingly been insinuated into school books and curricula. I am especially concerned to see that *all* kids are exposed to a reasonable view of what science is: how it is done, by whom and for what purpose. I also check to see how some of the greatest ideas in the history of thought — ideas such as the tremendously old age of the Universe, the solar system, planet Earth, and life, as well as the very notion of evolution — are presented. And, I check to see how the relatively simple ideas connecting biological phenomena with processes — the conceptual basis of biology — are presented. The ideas themselves may be simple, but they can be tough to get across to educated, relatively-sophisticated adults, let alone younger minds.

Thus, reviewing *Modern Biology* presented me with a rather familiar task, and I am happy to report that I find the text passes pretty much with flying colors. Any book that pronounces evolution to be both a recurrent and *unifying* theme of all biology is taking a firm stand against creationist-appeasement and adopting a strong intellectual stance that emphasizes the connectedness of all living things. After all, with what we have learned about the complex intracellular world of molecular biology, it would be possible to draft an informative, up-to-date biology text without stressing the unity afforded by evolution. But evolution is mentioned early in this book, and is discussed in detail in the fourth section. It is not at the book's very end, where it has been ensconced in other texts, no doubt in the hopes that the school year would end before the teacher had time to cover it.

Modern Biology is organized effectively, reviewing general biological concepts and principles, then examining biochemistry, molecular biology, genetics and cell biology, before turning to a general consideration of evolution. The unit on evolution is generally well-written

and well-organized, although the characterization of natural selection was neither pithy nor informative. In general, the discussion seems fairly up-to-date, but perhaps just a bit too skimpy to really get the ideas across.

By far, the greatest amount of text is devoted to an informative and even entertaining review of all forms of life, from bacteria through humans. The book concludes with ecology, which at first might indicate that ecology has replaced evolution as the forgotten subject at the end of the book. However, the bulk of the text is devoted to the genealogical interconnectedness of living creatures, and ecology cuts right across this grain. In view of the author's stress on evolution as an organizing principle, there is really no convenient place to include ecology. But, with its focus on environmental problems, the ecology section dovetails very nicely with the review of human biology that immediately precedes it. The human biology section, organized by anatomical/physiological systems, includes much-needed discussions of reproductive biology and sexually-transmitted disease (AIDS is highlighted), as well as the effects of drugs and alcohol. Throughout these sections, the book adopts a frank, but decidedly non-preachy, tone. I would welcome my own children being assigned to read it.

The basic nature of science in general is well-presented; there are frequent side-bar "features" scattered judiciously throughout the text that deal with scientists and how they do their work, about technological advances in scientific study, about scientific writing, and about topics of current interest to society at large. I was gratified to see science presented as a process conducted by humans essentially no different from the average inquisitive person who doesn't mind being a bit meticulous, logical, and persistent when asking questions about Mother Nature. Each of the 53 chapters begins with a hint of the major theme, and ends with a variegated menu of pedagogical reinforcers, including vocabulary, review, critical thinking, and extension. I felt some of the questions could not really be answered on the basis of the text, e.g. "What is the theory of punctuated equilibrium?" More disturbing, I thought that some of the questions seemed to imply that a short, snappy, definitive answer exists when there really is none, e.g. "What is the difference between a hypothesis and a theory?" The text does, on occasion, present material a bit too rigidly. On the other hand, I encountered numerous statements to the effect that scientists "disagree" or are "unsure" — not to dodge controversy, but to indicate that not all the answers are known. This, apart from being an accurate assessment of the situation, happily paints science as an ongoing human enterprise rather than a machinelike accumulation of absolute fact.

I found poor printing on some of the pages, but noticed surprisingly few errors. Twice in the book, the author erroneously states that fossils can routinely be dated with radiometric techniques — whereas they seldom can be so analyzed. But it is amazing to see so few errors in such a large undertaking. I found the illustrations to be attractive, informative and very effective, particularly those dealing with biochemistry and molecular biology.

In short, the author does right by his material, his prospective student readers, and their teachers. If one of my kids brings *Modern Biology* home from school one day, I'll be content.

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Just The Facts

by Hans Andersen

Modern Biology is a beautifully-illustrated textbook containing hundreds of fascinating photographs, diagrams, and illustrations. Few other positive statements can be made about the text because it is little more than a series of "one liners" about an incredible number of biological facts. Explanations are inadequate, scant or non-existent, but almost everything is mentioned.

The proliferation of demands by state departments of education have forced authors to add considerable amounts of factual information to textbooks. To make room for these facts, books have been enlarged and more significant information has been eliminated. *Modern Biology* has 53 chapters and 878 pages — a large book! I charted the objectives for its first, middle, and final ten chapters, and then classified them using Bloom's Taxonomy.

	First	Middle	Last	Total
KNOWLEDGE OBJECTIVES				
Identify	3	3	10	16
List	8	15	11	34
Name/State/Tell	10	6	9	25
				75
KNOWLEDGE COMPREHENSION OBJECTIVES				
Evaluate	1	0	0	1
Outline/Trace/Diagram	2	1	1	4
Relate	1	1	3	5
Define	7	4	7	18
Describe	17	26	26	69
Give Examples	5	2	3	10
				107
COMPREHENSION OBJECTIVES				
Predict	1	0	0	1
Summarize	7	7	11	25
Explain	9	9	12	30
Discuss	2	1	0	3
Compare/Contrast	11	9	0	20
Distinguish/Differentiate	8	6	10	24
				103

I found 75 knowledge-level objectives, 107 objectives that were borderline knowledge/comprehension, and 103 objectives that were comprehension-level. I did not find any higher level objectives nor did I find any objectives that called for quantifying other than measuring and counting. Two words that suggested higher-level thinking, evaluate and predict, really didn't require that much thought in this text. Only one of the 285 objectives checked could be considered higher than comprehension.

Chapters contain a variety of parts. First, there is an introduction that includes a summarizing paragraph, a chapter outline and the "Chapter Concept" which tells students what to look for or pay attention to as they proceed through the chapter. Chapters are divided into sections that are typically about five pages long, and these are preceded by a listing of section objectives. Also contained in each chapter are page-long writings drawn from the works of popular authors such as Lewis Thomas and Rachel Carson; a laboratory; a piece on biotechnology or on the work of a practicing scientist; and a chapter review composed of a list of vocabulary words. The average number of vocabulary words per chapter in the 30 chapters I studied was 33.3. Latinized scientific names of plants and animals are not included in this calculation, so there is actually far more vocabulary included in the text. Other chapter items include multiple choice questions; a critical thinking section that asks only for explanations and suggestions of how the students may study; and a section called extension. This same pattern was found throughout the text, and I felt that most chapters were boring and repetitious.

The chapters are organized into ten units with an insert between units that poses a biological problem, and explains how this problem connects to science and careers. I did not discover any other attempts to extend biology into other disciplines or the real world.

The "Laboratory Exercises" I examined were cookbookish and unimaginative. Most of the laboratories required little more than observation, and students were told exactly what to observe. Admittedly, it might be necessary to begin the sophomore class with guided exercises, but as the year progresses, students should be required to become more responsible for the design of procedures, decisions about how data should be displayed, and how conclusions should be communicated. There is nothing like this in this text. The laboratories at the end are the same "follow-the-steps" type as were found at the beginning. Expectations for the students are that they should do the lab and memorize it!

I am very familiar with *Modern Biology*. This edition is superior to previous editions because it states that "Biology" has major themes and one of these is evolution. Evolution has been given a more prominent place, but it is still a far cry from the attention that it ought to receive. The chapters on evolution are replete with statements of what the scientists "say," but what they say is unimportant! What is important is the evidence, which is interpreted by scientists. Of equal importance is the fact that scientists must make data, as well as their interpretations, public— open to inspection by everyone. Every scientist is, by choice of profession, a target of every other scientist and the rest of the world.

This text, like most science texts, fails to portray the nature of a scientific theory. It seems to indicate that a scientific theory is something you can choose to support or not, but it fails because it does not warn the reader of the volumes of data which are behind the scientists' conclusions. Furthermore, it makes a discipline I love boring. I urge all biology teachers who prefer to ask, "How does it make a living?" and not, "What is its name?" to avoid adopting this book.

Modern Biology has been a "best" seller since the 1920s. It has, progressively, become a better looking text, BUT, pedagogically it has not become a better book. Its emphasis has been facts, facts, facts, while the need for curriculum emphasis has been thinking. I can not and do not recommend this textbook to anyone!

Hans Andersen is a faculty member in the Department of Education at the University of Indiana.

It is Time

by Douglas J. Futuyma

To judge from the knowledge of biology I find among college freshmen, high school classes frequently emphasize "skin-in" biology — molecular, biochemical, and physiological aspects — to the detriment of organismal ("skin-out") levels of the subject. There is a common perception that "skin-in" biology is more "scientific" and more relevant to human concerns, especially health. Obviously, this part of biology is indispensable and much of it is exciting, but it is just as important to teach about organisms, when every week newspapers announce a new environmental threat, when countries face famine, and when deforestation and desertification threaten the extinction of more species than at any single previous time in Earth's history.

If, moreover, biology is to be taught as an intellectually coherent discipline rather than as an unending multitude of facts and definitions, it needs a unifying theoretical structure. That structure — the only truly comprehensive theme uniting all of biology — was provided in 1859 by Charles Darwin. But to judge by most students' knowledge of evolution, one would never guess that this is one of the milestones of science and of human thought, nor that it is the light that illumines every fact of biology. Happily, *Modern Biology* gives organisms equal standing with their insides, and stresses evolution as a theme, beginning with the very first page of the text. Nevertheless, at times the text seems to shrink from a full-throated affirmation of evolution that the intellectual development of its readers deserves.

More than half the book is devoted to "skin-out" biology; if anything, molecular and biochemical biology may be somewhat slighted, although genetics, cell biology, and human biology are well-covered. I applaud the author

for ending the book with a unit on ecology, and this with a chapter on "Protecting Life." Few messages can be so important. The diversity of living things is fundamentally fascinating and appealing, and more than any other aspect of biology is likely to quicken the imagination of biologists-to-be. This, too, the book covers extensively and lovingly, with copious illustration.

I must, however, draw attention to some flaws in what has clearly been a project motivated by good intentions and executed with considerable competence. First, there are errors ranging from trivial to substantial. For example, the pupal stage of insects is not "also called the imago," most human characteristics are not "usually controlled by a single gene," the genus of flax is *Linum*, sea urchins are *radially* symmetrical, and the living coelacanth should be referred to as *Latimeria chalumnae*. It is not true that most snakes are constrictors, nor that sirens occur in southern Europe. It is doubtful that red leaves of poison ivy warn animals of toxicity, that frogs' brains enable them to contend with a more varied environment than fishes', or that chordates arose from a radially symmetrical, sessile ancestor. Also, classification and identification, which are two different things, are confusingly treated together as if they were one.

Second, *Modern Biology*, like most textbooks, tends to present science as facts, without much discussion of where the facts come from or how incomplete they are. To be sure, some history is offered — Pasteur's and Mendel's experiments, for example. But how much richer the subject would be if the student learned how we know that the genetic code is universal, or that DNA replication is semiconservative, or that some traits are governed by more than one gene locus!

Third, the figures are somewhat inadequate. A figure intended to illustrate mammalian tooth types presents an occlusal rather than a lateral view of a monkey's teeth, so they all look much the same. Many photographs do not have the detail or illumination needed to display the features claimed in the captions.

Fourth, evolution is treated remarkably gingerly, considering its apparent place of pride. Many of the chapters on organisms are forthright (e.g. "mammals evolved from a group of reptiles called therapsids"). However, the chapters that explicitly treat evolution are rather more wary. "The fossil record," when we first encounter it, "could be interpreted to mean that species evolved from more ancient organisms." "Archaeopteryx," the most exquisite intermediate between major taxa, "may represent an evolutionary link between reptiles and birds." There is simply no justification for such temporizing, nor for saying that "vestigial structures can be viewed as evidence for evolution," (they are), or that the universality of cytochrome c is evidence that organisms "probably descended from a common ancestor." In these and many other contexts, the author presents evidence for evolution, only to back off and imply that it may be weak. And, why place on the student the burden of "critically evaluat(ing) whether (the evidence) indicates that species may have arisen by descent and modification from other species?" Why, indeed, when the student cannot be expected to have the critical knowledge and background to make such an evaluation? To make matters worse, the author fails to use some of the best evidence for evolution. For example, directional natural selection is illustrated by a hypothetical example rather than any well-known, real cases such as the evolution of insecticide resistance.

It is time that students learned, in no uncertain terms, that during the 130 years since *The Origin of Species*, many hundreds of biologists and paleontologists have adduced evidence for the historical reality of evolution, that it is supported by or at least consonant with every observation in every realm of biology, and that the vast majority of the thousands of professional biologists working today consider evolution a fact. It is time students learned that a scientific "theory" is not a speculation, nor even a hypothesis, but a coherent body of principles that are held to explain observations. The theory of evolution, properly so called, is a complex theory of *causes* — including natural selection and mutation — that bears the same status in biology that atomic "theory" does in chemistry or quantum "theory" does in physics. Like these other theories, evolutionary theory is subject to amplification and revision as new understanding and knowledge accrue. But the historical reality of evolution — the common descent of organisms that the theory of evolutionary mechanisms is meant to explain — is a breathtaking, grand statement of fact, as fully fact as the revolution of the planets about the sun. To suggest that the evidence for evolution is any weaker than the evidence for physiological or hereditary mechanisms is intellectually insupportable.

I congratulate the author on a product that, notwithstanding my criticisms, bears every mark of intelligent, conscientious preparation. From what I have heard, it may well be far ahead of the pack not only in its treatment of evolution but of biology as a whole. I hope the sales will warrant another, even more courageous, edition.

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CANDID APPRAISALS OF SCIENCE TEXTBOOKS

IN THIS ISSUE:

Merrill Biology 1988 teacher's edition ISBN = 0-675-06121-0 **High School**
Merrill Publishing Co. Elhi Division, P.O. Box 508, 1300 Alum Creek Dr., Columbus, OH 43216

Reasonable Fact Similes Merrill's *Biology* is a text designed for students who will not attend college. Thus, it is critical that such a text (and course) be attractive, stimulating, and capable of training informed future citizens. But, aren't these appropriate goals for any text? In fact, one might ask, "What does the college-bound student require that the non-college-bound student does not?" Some would respond that while all students should gain an overall understanding and appreciation of living things and the ability to think critically, college-bound students may need more information which prepares them for future courses. Our reviewers felt that, while *Biology* attempted to simplify explanations, there was too much information given in too much detail for students not headed for college. This surfeit extended into the information and instructions for teachers. What does seem appropriate for reaching all students, and which, with noted exceptions, appeared to work well in this text are: 1) illustrations that pique student interest and convey important concepts; and 2) common, everyday examples that help explain complex biological processes or phenomena. Such analogies and similes certainly can be effective teaching tools, as long as the student is familiar with the comparative stems. Overall, our reviewers felt that this text had much to be commended, and that, despite identified flaws, its audience would benefit from its use.

This is the last issue of the first volume of *Bookwatch Reviews*. Throughout the past year, we have learned a lot about the publication business. Of course, learning should be a continual and cumulative process, and we will carry our new knowledge into the second year and volume. One of the important lessons learned was that we need to accommodate better our workforce and the schedules of our busy reviewers. We also want to increase the number of books we evaluate. Thus, our second volume will consist of six issues, and each bimonthly publication will contain three reviews of two different science texts. There will thus be 12 books reviewed in 1989. We feel that this is a move toward greater publication efficiency while providing our readers with more analyses of science textbooks. Please join us in our second year.

Gordon E. Uno, Editor
William V. Mayer, Editor-in-Chief

Meeting Our Responsibilities

by David M. Armstrong

Merrill's *Biology* has a lot to recommend it. It sets a formidable goal: making terminal biology meaningful. We seldom have further opportunities with students who are not college-bound. Ours is the "insistent present" of which Whitehead wrote, with all its implicit responsibility. This text addresses that responsibility in subject matter, conceptual level, and attitude toward students, biology, and life.

There is generous support for instructors in the Teacher's Edition. Indeed, there may be too much help. (How do we stay alive as teachers when the answers all are known?) The introduction emphasizes performance objectives, thereby emphasizing rote learning rather than inquiry, and vocabulary development or skills acquisition rather than those notoriously elusive (but fundamentally important) affective changes that we all expect of students. Sometimes the teaching tips are misleading. "Ask students to investigate why the human life span has increased." Actually, it hasn't increased much, except on average. The important insight is that average age at death used to be prior to or early in the reproductive years, whereas now it is postreproductive.

Some review questions ask for real inquiry and could lead to novel insights. An example: "If a scientific breakthrough were to occur in the slowing of aging and cancer, what type of research would the scientists be doing?" Unfortunately, that question is posed to teachers, not students. Will teachers take time to work it in?

Every effort is made to keep vocabulary manageable, which leads to confusion if a key term is missing. As an example, for want of "seed leaf" we get into a bind. First, students learn that "one kind of plant (gymnosperms) produces seeds with no outer covering." Students familiar with pine cones, or with juniper or yew "berries," are going to wonder about that. Even the ignorant could be confused, however, because the text then states "scale-like parts of the cone cover the seeds as they form" and "spores are not as well covered as are the seeds of conifers."

Simplification is sometimes overdone. The legend for one photograph states that "the leaves of spinach plants can be eaten." This surely talks down to a reader who also is supposed to decipher a complex diagram of kidney function. On the other hand, authors occasionally encourage

teachers to undo their efforts to minimize detail. Is it enrichment or encumbrance to "have students use a reference to determine the exact names used to describe each phase of mitosis"?

Illustrations are generally excellent, with an agreeable balance among line art, drawings, and photographs. In an excellent photo essay, the student is led to compare non-human senses with human cultural metasenses—sonar, radar, infrared, and radio/TV reception. On the other hand, more variety would be useful in Chapter 11 where I got dazed looking at red arteries and blue veins on page after page. Some figures are confusing. "What is the largest biome on Earth?" is an important question, but one I had trouble answering from a cursory glance at Mercator's distorted Earth. If the most extensive biome were the taiga, as one might guess from the map, Earth's five billion people would be even hungrier than they are today. Some of the illustrations in Chapter 9 look more like ones from *Good Housekeeping* than from the lives of real teenagers. Because students live on junkfood, why not follow a pizza from lunch-counter to mitochondrion? And how can one responsibly discuss the human ear with this clientele without a cautionary comment on the effects of noise pollution from a "Walkman"?

The text is remarkably free of overt errors. However, not all "organs and systems develop from the middle layer" of the flatworm, and the statement that "water moves by osmosis to all parts of the plant and takes with it needed materials" is sure to confuse the alert student. Also, there are errors of omission. It is noted that mosses are restricted to moist habitats because they are nonvascular, but their reliance on swimming sperm is not tied in with this important piece of ecology.

Some problems are more subtle and conceptual. After a fine discussion of theory and its relationship to hypothesis and experiment, cell "theory" is used as an example, and that is barely (if at all) a theory in the sense used in the text. Chapter 8 is entitled "Complex Animals." Relative to what? They will never convince a sapient squid that it is less complex than a sea cucumber. The text mostly does a good job of conveying *general* biology, with humans a common example, although sometimes the human example is wrongly implied: "All living things age. Loss of hair, wrinkled skin, and loss of memory are some of the common signs of aging." But not for chestnuts.

The text encourages sensitivity toward organisms, including fellow humans, and language is laudably free of gender bias. A photograph of wheelchair athletes without comment is subtle and effective, and that of an individual with Down's syndrome is a beautiful statement. The text is mostly non-judgmental, and the chapter on drugs is fairly thorough, direct, and not at all "preachy."

Analogies are claimed as a strong feature of the book, and the text mostly delivers. The propulsion of an untied balloon and a squid *are* alike. Some analogies, however, are forced, and others presume insights that students may not have (molecular genetics and the computer, for example). Some analogies actually are confusing. Bakeries and maple leaves are *not* both food-making businesses; bakeries merely process the indirect production of leaves of grass.

The text claims to face controversial topics squarely, and, in some cases, does so. AIDS is difficult and can be controversial, but the text's coverage, although brief, is fairly forthright. Topics sometimes called "controversial" (but actually just fundamental) are treated without apology. The description of human reproduction and development is excellent. However, neither abortion nor contraception is mentioned, and that is irresponsible. Anyone who can deal with amniocentesis and *in vitro* fertilization can reasonably be asked to read about condoms, "the pill," and unwanted pregnancy. Evolution is presented as an observable phenomenon and natural selection as a robust theoretical model of how evolution happens. The coverage is perhaps simplistic, but it is intellectually honest.

Biology, An Everyday Experience is a text worth considering. Its problems are few, will be countered by effective teachers, and are more than compensated by its virtues. First among these is that it addresses deliberately the needs of the majority of our students—students for whom high school biology is the last chance we have to introduce the wonders of life and the perils of living together on a small, round, beautiful planet.

David M. Armstrong, is Director of the University of Colorado Museum and Professor in the Natural Science Program, and is interested in the science education of non-scientists.

Practical Biology

by Ross Koning

The Teacher's Edition of Merrill's *Biology* represents a course development system more than a simple textbook. This system must be an instructor's and administrator's delight. The instructional aids make it easy enough for any teacher to walk into a classroom and be reasonably prepared to teach with minimal advanced reading. The fact that the laboratory and instructional resources are contained in one book should make logistics and expenses reasonable. The annotated edition makes correcting question responses and marking laboratory results possible even for untrained personnel.

There is a rich diversity of reviews, questions, research ideas, tests, and summaries that makes individualized teaching approaches possible. I was disappointed, however, to see few writing assignments among this diversity. Most of the questions posed to students were of the short-answer type. While this method is quite efficient in answering and grading, it offers little reinforcement of writing skills. I am fully aware that an instructor typically faces around 180 students each day, and the prospects of grading 180 essays at night are discouraging at best. Nevertheless, I wish the questions at least directed students to respond in complete sentences. "Writing across the curriculum" projects might include this text if it were provided with writing supplements.

This book is intended for secondary students not intending to pursue a college degree. I found the practical, everyday-life parallels to biological systems interesting and enlightening. I firmly believe that attaching practical explanations to biological processes is a method ideally suited for learning by non-biologists. It is a system I use at the college level.

The book's diagrams usually explain the process or system very well and, in fact, are more functional than those in most college texts. On the negative side, the figures are largely compressed into the margins. This leads to some unnatural arrangements; for example, a diagram of

the pulmonary system has a vertically-oriented heart with the right lung above the heart and the left lung beneath. In other cases, a multiple figure explains a process (such as the menstrual cycle) with numbered labels, but because the numbers are out of sequence, it is hard to follow the process being described. Sometimes the diagram is so crowded that complete parallels are not shown; in one case, while factory wastes are pictured, human wastes are shown only as the word "wastes" next to the view of a muscle. This leads to a possible misconception that the muscle is a waste-storage area. Of course, part of this cramping is due to the large number of diagrams used throughout the text. This is a heavily-illustrated book; a strength and a weakness together. I would prefer to have more room for critical diagrams. One area that might be reduced to add space is the photographic spread at the chapter and unit headings. While beautiful, these photos are not very functional.

The topic coverage of the text is comprehensive, but the detail on each topic is probably excessive for the targeted students. While the book is an excellent resource, many students may find the text difficult to read. The level of detail exceeds that in many introductory college texts for non-science majors.

There are a few cases of inaccuracy. This book is typical among biology texts, confusing gene and allele and leaving incorrect ideas about one "gene" being dominant to another "gene". While the human atrium appears smaller upon dissection, when functioning its contained volume *must* be identical to that of the ventricle it fills on alternate strokes. Unfortunately, the inaccurate statement of size is common in textbooks because of authors' experiences in dissecting dead animals rather than logical thought about function. I wish obvious discrepancies like this were used as tools to foster critical thinking by students.

In a slightly different example, fertilization in fishes is accurately described in vague terms of external vs. internal in the text, but the adjacent figure legend makes an absolute statement that fishes have external fertilization. Of course, students will have observed many guppies in the laboratory exercises of this book and may have observed fish copulation. It is critical that instructional programs reinforce students' trust in their own observations.

The laboratory exercises are frequently exciting and positive experiences. On the other hand, some revisions are in order. In one activity, the effect of protease on gelatin and the effect of amylase on starch are tested. In the questions, however, students are asked whether the enzyme digesting starch could also digest protein. The question of specificity is beyond the scope of the observations and yet is important enough to warrant inclusion. Why not have the students observe the effect of protease on starch and that of amylase on gelatin? Of course the results will be negative, but this is an important point: we often learn more from negative results than from positive ones in science. We need to train citizens about honesty in science and about the integrity, reality, and importance of "negative" data.

Perhaps a more critical error is made in the activity where students dissect a preserved anemone and are asked to describe the functions of its structures! An activity should reinforce the idea that "data and observations" are *not* factual knowledge gained from reading the text. There is no way to "observe" functions in a preserved anemone, and functions ascribed to structures by students in no way constitute "data" collected by a student during the activity. Moreover, the authors should have students record observations that *can* be made (color, size, form, presence of other preserved organisms), and then have students distinguish between what they read and what they actually see.

The shortcomings mentioned in the paragraphs above are common to most biology textbooks. Biology as a science disappears in a sea of information generated from the process itself. It is commonly assumed that the "study of life" is already well known and thoroughly explained previously to students. This book has one chapter on "science," but like most others, it reinforces that chapter very weakly throughout the rest of the text.

In summary, this book represents an excellent teaching system and presents the data of biology in a comprehensive and detailed manner. It provides an excellent resource for teachers and students, and, with some revisions, could have tremendous impact on the teaching of biology.

Ross Koning is a plant physiologist who teaches biology to both majors and nonmajors in the Biology Department at Eastern Connecticut State University in Willimantic.

Making the Right Connections

by Mary D. Coyne

Biology: An Everyday Experience is a text that covers the entirety of biology and is aimed at the "non-college-bound student." It begins by introducing general terms, measurements, the scientific method, cell structure, and basic function. This is followed by discussions on the classification, anatomy, physiology, and reproduction of both plants and animals. The discussion on reproduction naturally flows into explanations of development, inherited traits, genetics, DNA, evolution, population biology, and finally ecosystems. It is a text that has many positive attributes, but it also is one that contains some areas that bother me as an educator. Let me speak to the positive first.

The scientific vocabulary was kept to a minimum in many sections, and words in common usage were substituted. For example, echinoderms are classified as spiny-skinned animals, coelenterates as stinging-cell animals, and mollusks as soft-bodied animals. The Latin- and Greek-derived names are listed in the margins of the Teacher's Edition. The bones of the human skeleton are labeled with both common and medical names. While these examples indicate an effort to reduce terminology, one wonders why terms such as the "newton" and the "kelvin scale" are introduced, put in the vocabulary list, but never explained or used again.

The text contains many excellent pictures, photos, and diagrams which are directly tied in with the discussions in the chapter. They are used for comparisons, and for demonstrations of tissue structure, cell structure, animal/plant diversity, and dissections. I found myself consulting these illustrations frequently as I read through the text and felt they were an integral part of the book. Occasionally, "photo essays" precede a new subdivision of the book. These essays attempt to make connections between biological phenomena and common events or things. Some connections work better than others. For example, the types of seed dispersal are the subject of one photo

essay—wind dispersion is related to the movement of a hot-air balloon, water dispersal to a floating raft, ejection to a sling shot, and animals as seed-carriers to velcro closures on a sneaker. The best use of photos, however, is to depict experimental results. In some cases, photos are used to show the results in both the control and the experimental group (plant growth in the light/dark, or in the dark). In other cases, they provide the data for an activity, e.g. one suggests comparing blood cells from different animals. The text illustrates smears from a camel and a bird. If the teacher cannot obtain blood specimens, then at least two are readily available for some measurement and discussions.

The text uses familiar everyday events in its discussions of biological phenomena. For example, the amount of drug in the blood is shown to be a balance between the rate it is taken in and the rate of its removal. This is compared to a sink filling with water at the same time it is being drained. I was particularly pleased with the chapter on drugs. It is a very rational, reasoned approach explaining how the drugs worked. The authors discuss reading labels on bottles with usage, doses, and warnings. The chapter covers aspirin, depressants, decongestants, mind-altering drugs, antacids, cocaine/crack, caffeine, nicotine, and alcohol. In other areas of the text, modern medical techniques are explained, such as heart and kidney transplants, hip replacements, *in vitro* fertilization, and CAT scans. Career Closeups are vignettes explaining occupations which require some additional schooling, or on-the-job-training, but in all cases they promote the idea that a high school education is necessary. I must admit, however, I had never thought of lumberyard work as a job in biology.

I reviewed the Teacher's Edition, and there was a great deal of material provided. Some of this included extra activities and experiments; research topics in the library; bulletin board material for major units; and interesting asides or information related to possible student questions. An experienced teacher might find most of the teacher information worthless and condescending, but a beginning teacher might find some useful suggestions.

On the negative side, it appeared to me that the first third of the text had several flaws. The most glaring problem to me is related to the processes basic to the function of the cell. The authors only discuss osmosis and diffusion across the cell membrane and not active transport or the components of the cell membrane. Moreover, they incorrectly use the diffusion of oxygen occurring via pores in the membrane as the basic description of diffusion. It seems the authors consider the group of students for whom this book is written to be incapable of understanding concepts such as active transport or membrane components. I disagree. I find that students grasp such ideas easily, especially if they are reiterated in the discussion of each system. The authors freely discuss DNA, DNA replication, mutations, and recombinant DNA—why not active transport?

In the first activity of the text, the students are asked to look at a paramecium using a microscope, to draw the organism to scale relative to the field of vision, and then to calculate its actual size. This is fine, but now the student is given a multiplication factor to use in arriving at the answer. Nowhere is there any information about why this correction factor is used or how it was determined. And there is no information for the teacher in case a student asks. To me, this is an important missing link. The students are asked to do and not to understand. The second activity is titled, "What will a green liquid do to a piece of aluminum?" The students are told to put a piece of aluminum foil into two different tubes containing a green liquid. In one tube the foil deteriorates, and in the other it doesn't. That's it. The student is never told why there is a difference or what is causing the difference. At this point, if I were a student, I would tune out.

If you can get beyond the first two chapters, you will find this a usable text. It does try to fulfill the needs of its particular student audience, and the level of understanding does improve as you proceed through the book. My parting question, however, is "Do 'non-college-bound' students need to learn, actually memorize, the entirety of biology, or would it be better for them to savor and to *understand* a smaller fraction?"

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